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3643

TRANSMITTAL FORM

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First Named Inventor	Marvin J. Williams, Jr.
Art Unit	3643
Examiner Name	Jeffrey Gellner
Attorney Docket Number	—

ENCLOSURES *(Check all that apply)*

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment/Reply
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Reply to Missing Parts/ Incomplete Application
  - ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition
- ☐ Petition to Convert to a Provisional Application
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Date	4-17-07	Reg. No.	33,744

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENTS

APPEAL BRIEF

IN RE APPEAL OF MARVIN J. WILLIAMS, JR.

Inventor and Applicant: Marvin J. Williams, Jr.

Address: 1411 Bell Ave.

New Buffalo, Michigan 49117

Application No.: 10/747,728

Technology Center: 3600

Group Art Unit: 3643

Examiner: Jeffrey Gellner

Filing Date: December 29, 2003

Title: Improved Combined Intercropping and Mulching Method

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4-18-07
modified

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REAL PARTY IN INTEREST

This appeal is brought by Inventor and Applicant Mr. Marvin J. Williams, Jr., a natural juristic person, who is the real party in interest and Appellant in this proceeding. This appeal is brought from the final rejection of all claims in Application No. 10/747,728.

RELATED APPEALS AND INTERFERENCES

There is a prior appeal from final rejection of all claims in Application No. 09/752,956, now U.S. Pat. No. US 6,631,585 B1. There are no decisions of a court or the Board of Patent Appeals and Interferences.

STATUS OF CLAIMS

Claims 1 through 20 inclusive are on appeal.

STATUS OF AMENDMENTS

Appellant filed a post final-rejection amendment on March 24, 2006. This amendment included twenty proposed amended claims. Evidence Appendix, Exhibit D, pages 11-19. It also included changes to the specification which the government required in its second final office action. *Id.* at pages 2-10. The brief portion of the amendment addressed why each proposed amended claim overcame the government's final rejections. *Id.* at pages 20-27. The government denied entry of Appellant's amendment and request for reconsideration on April 4, 2006. *Id.*, Exhibit E.

On June 23, 2006 Appellant filed a post-notice of appeal amendment pursuant to 37 C.F.R. 41.33(a). Evidence Appendix, Exhibit J. This amendment (1) modified claims to eliminate dependence on withdrawn claims; and (2) modified antecedent basis within claims. The examiner denied entry of this June 23, 2006 amendment in his July 7, 2006 Advisory Action.

SUMMARY OF THE CLAIMED SUBJECT MATTER

Claim 1

The intercropping and mulching method of independent Claim 1 does not require herbicides, pesticides, fertilizer or manure. Evidence Appendix, Exhibit G (Specification as originally filed), page 2, line 22. It does include no-till planting of an annual green manure crop. *Id.*, page 16, lines 15-16; Figure 2, reference numerals 17b,18b. The annual green manure crop is mowed the following spring. *Id.,* page 21, lines 8-9; Figure 3, reference numerals 17,18; Figure 4, reference numerals 18, 18a.

The annual green manure crop is then combined with organic debris such as soybean stems, cornstalks, desiccated soybean roots and intact nitrogen nodules. *Id.*, page 3, lines 6-7; page 21, lines 10-14; page 38, lines 24-26; Figure 3, reference numeral 19; Figure 4, reference numerals 5, 18 and 45. A portion of green manure and residue is tilled into the soil to a depth of approximately nine to fourteen inches. *Id.,* page 24, lines 8-10; Figure 5, reference numerals 5, 18, 18a and 45; Figure 6, reference numerals 18, 44 and 45; Figure 7, reference numerals 18, 44 and 45.

At least two commercial crops are then intercropped within the soil containing the tilled portion of combined green manure. *Id.*, page 24, lines 8-14; page 26, lines 5-9; Figure 11, reference numerals 8, 9, 12 and 90. The remaining portion of green manure and organic

debris is mixed, mowed and chopped as combination mulch over the intercropped soil. *Id.*, page 38, lines 16-26; page 39; page 40, lines 1-16. The farmer sprays the combination mulch upon the soil which is intercropped. *Id.*, page 40, lines 16-18; page 43, lines1-17; Figure 16, reference numerals 8, 9, 20 and 45.

The combined green manure provides nutrients and a ground cover for the commercial intercropped crops, as well as ground cover during the winter. *Id.*, page 2, lines 20-24; page 3, lines 5-10.

Claim 9

The farmer initially plants an annual green manure crop. Evidence Appendix, Exhibit G, page 16, lines 25-26. He mows the green manure crop the following spring and combines it with organic residue to form combined green manure. *Id.*, page 16, line 18; page 21, lines 11-13, 15-18. He blends the combined green manure into the soil which will be intercropped. *Id.*, page 23, 24, and 25, lines 1-22. The remaining portion of the green manure crop is combined with organic residue to form combined mulch by mixing and chopping. *Id.*, page 21, lines 10-11.

The combined mulch is stored during the actual intercropping process. *Id.*, page 22, lines 9-11; page 38, lines 15-22. After intercropping, the farmer sprays the combination mulch upon the soil. *Id.*, page 42, lines 24-26; page 43, lines 1, 2; Figure 16, reference numerals 20, 45. The combined green manure provides nutrients to the intercropped commercial crops. *Id.*, page 3, lines 1, 2 and 16-17. The combination mulch provides ground cover and nutrients, as well as soil protection during the winter. *Id.*, page 3, lines 5-9. The green manure crop can be buckwheat, buckwheat and wheat, Austrian peas, hairy vetch, soybeans, annual rye grass or winter rye. *Id.*, page 20, lines 13-26; page 21, lines 1-5.

GROUNDS OF REJECTION TO BE REVIEWED UPON APPEAL

I. Whether Appellant's specification as originally filed is non-enabling under 35 U.S.C. section 112, first paragraph, with respect to post- notice of appeal proposed Claims 1 through 7, 9 through 13 and 15 through 20.

II. Whether Appellant's post- notice of appeal proposed claims 1 through7, 9 through 13 and 15 through 20, are enabled pursuant to 35 U.S.C. section 112, first paragraph.

III. Whether the government should have entered Appellant's changes to the specification?

ARGUMENT

I. Introduction

35 U.S.C. section 112, first paragraph reads in relevant part:

"The specification shall contain a written description of the invention, and of the manner and process of making and using it,...as to enable any person skilled in the art to which it pertains,... to make and use the same,...."

The test for enablement under section 112 is whether one reasonably skilled in the art could make or use the invention from the patent disclosure, together with information known in the art, without undue experimentation. MPEP 2164.01(Eighth Ed. 4th Revision, October 2005)[hereinafter MPEP], *citing* In re United States v. Telectronics, Inc., 857 F.2d 778, 785, 8 U.S.P.Q.2d 1217, 1223 (Fed. Cir. 1988). The undue experimentation factors include, but are not limited to:

(A) breadth of the claims;

(B) nature of the invention;

(C) state of the prior art;

(D) level of one of ordinary skill;

(E) level of predictability in the art;

(F) amount of direction provided by the inventor;

(G) existence of working examples; and

(H) quantity of experimentation required to make or use the invention, based upon the content of the disclosure.

MPEP 2164.01(a), *citing* In re Wands, 858 F.2d 731, 737, 8 U.S.P.Q.2d 1400,1404 (Fed. Cir. 1988). The application must provide a sufficient disclosure of necessary apparatus, if the apparatus is not readily available. MPEP 2164.01(b), *citing* In re Ghiron, 442 F.2d 985, 991, 169 U.S.P.Q.723, 727 (C.C.P.A. 1971).

The direction required to enable an invention is inversely related to the knowledge in the state of the art as well as the predictability in the art. MPEP 2164.03, *citing* In re Fisher, 427 F.2d 833, 839, 166 U.S.P.Q. 18, 24 (C.C.P.A. 1970). A single embodiment may provide broad enablement in cases which involve predictable factors. MPEP 2164.03. *citing* In re Cook, 439 F.2d 730, 734, 169 USPQ 298, 301 (C.C.P.A. 1971).

Moreover, the government must provide a reasonable explanation why the scope of protection provided by a claim is not adequately enabled by the disclosure. MPEP 2164.04, second paragraph, *citing* In re Wright, 999 F.2d 1557, 1562, 27 U.S.P.Q.2d 1510, 1513 (Fed. Cir. 1993).

II. Procedural history

Appellant filed his patent utility application in the above captioned case on September 29, 2003. Evidence Appendix, Exhibit G. After receiving the government's restriction/ election of species requirement, Appellant withdrew originally filed Claims 8 and 14. *Id.*, Exhibit H. In the first office action of March 22, 2005, the government indicated that

originally filed claims 9 and 11-13 contained allowable subject matter, but that they must be rewritten to (a) overcome rejections under 35 U.S.C. 112, second paragraph; and (b) include all the limitation of the base claim and any intervening claims. *Id.,* Exhibit A, page 6, fourth paragraph.

Also in the first office action the government rejected Claims 1-7 and 10 based upon 35 U.S.C. 103(a) obviousness. *Id.,* page 5, page 6, paragraphs 1-3. Thereafter Appellant overcame these rejections in his reply to this first office action. Evidence Appendix, Exhibit C, page 3, first paragraph (February 2, 2006 Second Office Action).

Nevertheless, the government's second final office action rejected Claims 1 through 20 contending that they were non–enabled by the specification. 35 U.S.C. section 112, first paragraph; Evidence Appendix, Exhibit C, page 2, third paragraph. The government also contended that the claims omitted crucial steps, and therefore they were non-enabled under 35 U.S.C. 112, first paragraph; Evidence Appendix, Exhibit C, page 2, third paragraph. This was the first communication in which the government raised this section 112 issue. Consequently Appellant did not have an opportunity to respond to this concern in his first office action reply.

In his Reply and Request for Reconsideration, and to place the application in better condition for allowance and/or appeal, Appellant amended the claims in accordance with the government's section 112 concerns. Evidence Appendix, Exhibit D, pages 11- 19; 37 CFR 1.116 (b)(3). Appellant provided paragraphs containing the information for the

government's requested claim limitations under section 112, second paragraph. Evidence Appendix, Exhibit D, pages 20, 21. Appellant also amended the specification in accordance with the government's requirement for modified agricultural terminology. Evidence Appendix, Exhibit C, page 2, first paragraph; *Id.*, pages 1-10.

The government did not enter the amendments to the specification or claims. Instead, it stated that amended independent Claims 1 and 14 required further consideration. Evidence Appendix, Exhibit E, page 3 (March 4, 2006 Advisory Action). Appellant filed this appeal on May 9, 2006. Evidence Appendix, Exhibit F.

Appellant confirms that Claims 8 and 14 were originally withdrawn without traverse in the proceedings below. Evidence Appendix, Exhibits H, I.

III. The specification as originally filed enables Claims 1 through 7, 9 through 13, and 15 through 20 pursuant to 35 U.S.C. section 112, first paragraph.

The specification explicitly contains all the information to enable Appellant's post notice of appeal claims pursuant to 37 CFR 41.33.

The government has the initial burden of establishing, by a preponderance of the evidence, why a person skilled in the art would not recognize in an applicant's disclosure a description of the invention described by the claims. MPEP 2163.04. The examiner must have a reasonable basis for challenging the adequacy of the written description. *Id.*

In support of its contention that Appellant's specification is not enabling, the government states in relevant part in its second final office action:

"Claims 1-20 are rejected under 35 U.S.C. 112, first paragraph, as based on a disclosure which is not enabling."

Appendix, Exhibit C, page 2, third paragraph.

The government further states

"[t]he harvesting of the first portion of the annual green crop and its mixing to become a combined green manure is critical or essential to the practice of the invention, but not (sic) included in the claim(s) (sic)is not enabled by the disclosure."

Id.

The government further states

"The independent claims recite 'spraying said first portion of said combination mulch,' but there is no step between mowing the annual green manure and harvesting and combining the (sic) its first portion to arrive at the combination mulch so it can be sprayed."

Id.

For combination mulch:

Appellant amended independent Claims 1 and 9 to include:

mixing, chopping and storage of a portion of the annual green manure crop with debris to create combination mulch. Evidence Appendix, Exhibit D, pages 11-12, 13-15; 37 CFR 1.116 (b)(1).

For combined green manure:

Claim 9: In reply to the first office action, Appellant added the claim limitations of mowing the annual green manure crop, and combining the crop with organic residue to form combined green manure. He also designated in Claim 9 that the soil is blended with this combined green manure. *Id.*, Exhibit B, page 16, lines 19-24.

In his reply to the second office action, Appellant also designated paragraph numbers, within the specification as originally filed, of paragraphs which explicitly contain the limitations of the claims. These paragraphs describe

(a) mowing the annual green manure plants,

(b) mowing organic debris,

(c) mixing the organic debris and green manure plants for either combination mulch or combination green manure, and

(d) chopping the green manure plants and organic debris to obtain combination mulch; or

(e) tilling combined green manure to into the soil.

Evidence Appendix, Exhibit D, page 20, lines 16 through 21; page 21, lines 1-15.

Appellant now expands this designation of paragraphs (but not exclusively), and also includes relevant figures, as follows:

a. Production of combination green manure

Paragraph 79 and Figure 4 describe and illustrate mowing of the annual green manure crop, residual cornstalks and other debris which become combined green manure. Evidence Appendix, Exhibit G.

Paragraph 80 describes the preferred conventional machine for mowing the green manure crop, residual cornstalks and other debris. *Id.*

Paragraphs 81 and 82 describe how the preferred conventional farm machine mows the green manure plants and organic debris. *Id.*

Paragraph 83 states that in other modes mowing and raking with other tools produce combined green manure. *Id.*

Paragraphs 84, 85, and 87; Figures 5, 6 and 7: These paragraphs and figures state and illustrate how mowed green manure plants, and residual debris such as cornstalks, are quick-tilled into the soil. These paragraphs also describe the preferred tilling machines. *Id.*

Paragraphs 86, 88, 89, and 90 describes how mowed green manure plants, residual cornstalks and other debris are blended into the soil with other than the preferred machine(s).

Id.

b. Production of combination much

Paragraph 78 states that the top half of wheat plants are mowed, chopped and blended with organic debris to become combination mulch. Evidence Appendix, Exhibit G.

Paragraphs 81 and 82 describe how the forage harvester machine mows, rakes and collects the mowed green manure plants and organic debris to become combination mulch. These paragraphs also initially describe how the preferred forage harvester machine blows the green manure and organic debris into a forage wagon for storage prior to mixing and chopping. They also state that other machines are appropriate for mowing and collecting mowed plants. *Id.*

Paragraph 133 describes how initial blending of combination mulch results from mowing and blowing of green manure plants and debris into a forage wagon.
Id.

Paragraph 134 and Figure 17 designate and illustrate a bale chopper as the device which chops the organic debris, cornstalks, soybean stems and green manure plants as combination mulch. *Id.*

Paragraphs 135 and 136; Figure 19: These paragraphs and figure describe and illustrate the preferred forage box wagon and preferred bale chopper for mixing and chopping combination mulch.
Id.

Paragraph 137 describes an alternative storage wagon for smaller amounts of green manure plants and organic debris. *Id.*

Paragraph 138 initially describes how the farmer attaches a bale chopper to a forage box wagon to produce combination mulch. Paragraph 138 also initially describes how a pipe and hose attach to spray combination mulch. *Id.*

Paragraph 139 states that the preferred bale chopper is gasoline powered. Paragraph 139 also provides an initial detailed explanation of how the preferred bale chopper attaches to forage box wagon around augers. *Id.*

Paragraphs 140 and 141 describe how green manure and debris are pulled toward the forage wagon anterior, through a discharge opening around the augers, and finally into a bale tube. *Id.*

Paragraph 142 and Figure 20 describe and illustrate in initial technical detail how to structurally and operatively attach the bale chopper to the forage box wagon. *Id.*

Paragraphs 143, 144 and 145 describe in additional technical detail how to attach a bale chopper to a forage box wagon. *Id.*

Paragraphs 146, 147 and 148; Figures 16 and 20: These paragraphs and figures describe and illustrate attachment of a pipe and hose to spray combination mulch over a field. There is also a disclosure of an alternative device to spread combination mulch over a small area.

Based upon these originally filed specification paragraphs and figures, Appellant concludes that his specification enables his post notice of appeal claims 1 through 7, 9 through 13 and 15 through 20.

Additional information is unnecessary under section 112 first paragraph, for enablement of persons skilled in the agricultural industry

Appellant's originally filed specification explicitly describes the method limitations of the claims and is commensurate with their scope. *See* MPEP 2164.08, third paragraph (scope of enablement of the specification must be commensurate with the breath of the claims). The description need only describe in detail that which is new or unconventional. MPEP 2163 II. A. 3. a., third paragraph, *citing* Hybritech v. Monoclonal Antibodies, 802 F.2d 1367,1384, 231 U.S.P.Q. 81, 94 (Fed. Cir. 1986).

A patent need not teach, and preferably omits, what is well known in the art. MPEP 2164.01, first paragraph, *citing* In re Buchner, 929 F.2d 660, 661, 18 U.S.P.Q.2d 1331, 1332 (Fed. Cir.1991). The test is not whether experimentation is necessary but whether, if necessary, the experimentation is undue. MPEP 2164.01 second paragraph, citing In re Angstadt, 537 F.2d 498, 504, 190 U.S.P.Q. 214, 219 (C.C.P.A. 1976). The guidance for

enablement of an invention is inversely related to the knowledge and predictability of that art. MPEP 2164.03, third paragraph, citing In re Fisher, 427 F.2d 833, 839, 166 USPQ 18, 24 (C.C.P.A. 1970).

The government contends that Appellant's specification does not adequately describe preparation of combination green manure or combination mulch. Appendix, Exhibit C, page 2, third paragraph. Appellant has previously identified specification paragraphs containing information which is the subject of the government's concern. Furthermore, a person skilled in the agricultural industry would routinely use a conventional forage and harvester-tilling machine, to mow and till crops. *See* MPEP 2164.08, fifth paragraph. This person would also predictably use gathering and cutting hand tools for smaller areas. *Id.;*

Similarly, a person skilled in the agricultural industry can connect a forage wagon so that crops are blown from a forage harvester and towards a forage box wagon anterior. *Id.* This person also predictably understands the structure and use of a bale chopper, and how to spray mulch with a hose. *Id.; see* MPEP 2164.03, third paragraph

In the pending case the government has not addressed any of the above considerations. Consequently it should withdraw its rejection of Applicant's disclosure and post-final rejection claims 1 through 7, 9 through 13 and 15 through 20. *See id*, fifth paragraph (Claims are not rejected under section 112 for non-inclusion of limitations which are presumed to be within the level of ordinary skill in the art).

IV. The government should allow proposed claims 1 through 7, 9 through 13, and 15 through 20 of Appellant's post notice of appeal amendment.

In its April 4, 2006 advisory action, the government contended that amended independent claims 1 and 14 required further consideration. Appendix, Exhibit E, final page.

The government has not explained how Appellant's reply to its second office action requires further consideration of independent Claim 1 (and now amended independent Claim 9). The government's search prior to the first office action should ordinarily cover an invention as ***described*** and claimed. MPEP section 904, third paragraph (emphasis added).

The first office action on the merits should present an accurate factual basis for rejection of claims if the rejection is based upon non-enablement under section 112, first paragraph. MPEP 2164.04 I., first paragraph. The examiner should always designate enabled, allowable subject matter on the applicant's behalf. MPEP 2164.04 I., third paragraph.

The applicant may rely upon the specification and claims as filed to support amended claims. *See* MPEP 608, first paragraph. In the pending case, all steps for production of the combination mulch and combination green manure were present within the original specification. *See* Appellant's Brief, *supra*. Consequently, the government should not require an additional search. MPEP section 904, third paragraph.

The government did not explicitly explain why it did not enter amended independent Claim 9. Appellant amended Claim 9 in reply to the second final office action to include as limitations: mixing, chopping and storage of combination mulch. 37 C.F.R. 1.116(b)(2).

Furthermore, Appellant has described other modes in the specification as originally filed supra. These modes provide for alternative machinery and tools, but the actual method steps remain the same (mowing, blending, storage, etc.) Consequently independent Claims 1 and 9 encompass the scope of his invention, and which includes alternative approaches to method steps. *See* MPEP 2164.08, seventh paragraph (claims are given their broadest possible interpretation which is consistent with the specification).

V. The government should enter Appellant's changes to the specification.

In its first and second office actions, the government requested that the term ---wheat grass--- be changed to "wheat" within the Brief Description of the Drawings. Evidence Appendix, Exhibit A, page 2, first paragraph; Exhibit C, page 2, first paragraph. Pursuant to the government's request Appellant changed the term ---- wheat grass--- to "the upper portions of young wheat and/or buckwheat plants" for consistency with the original specification. Appellant also changed the term accordingly throughout the remaining specification, to confirm with the modified terminology within the Brief Description of the Drawings. Evidence Appendix, Exhibit D, pages 2 through 10, page 26, third paragraph.

Appellant made these changes to place the application in condition for allowance and/or to remove issues for appeal. 37 CFR 1.116 (b)(1). He now respectively submits that they should have been entered prior to this appeal. MPEP section 714.13 II. (Post-final rejection amendment can remove issues for appeal and adopt examiner's suggestions). The government did not address this point in its Advisory Action of April 4, 2006, and so Appellant concludes that the specification changes were not entered. Evidence Appendix, Exhibit E.[1]

[1] Appellant has no record that the government entered the changes to the specification, which he made in reply to the first office action.

REQUEST FOR RELIEF

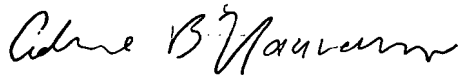
Wherefore Appellant respectfully requests the following relief:

1. That the Board enter an order finding that post notice of appeal Claims 1 through 7, 9 through 13, and 15 through 20 are enabled under 35 U.S.C. section 112, first paragraph;

2. That the Board enter an order finding that the specification as originally filed is enabling under 35 U.S.C. section 112, first paragraph with respect to Claims 1 through 7, 9 through 13 and 15 through 20;

3. That the Board direct the government to enter Appellant's specification changes made in response to the first office action and second final office action.

Respectfully submitted,



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On behalf of

CLAIMS APPENDIX

(Not entered) Claim 1: An improved intercropping and mulching method without artificial herbicides, fertilizer, pesticides and manure, said improved intercropping and mulching method comprising:

(1) no-till planting an annual green manure crop in the soil of a predetermined area;

(2) mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue from said predetermined area to form combined green manure, said organic residue comprising desiccated intact soybean roots and desiccated intact nitrogen nodules, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area to a depth of approximately nine to fourteen inches, said annual green manure crop remaining unmowed until tillage of said soil,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure, said first portion of said combined green manure being collected, chopped and stored until intercropping is complete, said first portion of said combined green manure becoming said combination mulch after said chopping,

(4) thereafter spraying said first portion of said combination mulch upon the surface of said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby, said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two commercial crops, said annual green manure crop and said organic residue protecting said soil of said predetermined area during the winter.

(Not entered) Claim 2. The improved intercropping and mulching method as described in Claim 1, wherein one of said at least two commercial crops comprises a legume.

(Not entered) Claim 3. The improved intercropping and mulching method as described in Claim 1, wherein one of said at least two commercial crops comprises soybeans.

(Not entered) Claim 4. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn.

(Not entered) Claim 5. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn and one of said at least two commercial crops comprises soybeans.

(Not entered) Claim 6. The improved intercropping and mulching method as described in Claim 1, wherein there are no intercropped plants other than said at least two commercial crops, said at least two commercial crops comprising said corn and said soybeans.

(Not entered) Claim 7. The improved intercropping and mulching method as described in Claim 6 wherein said corn and said soybeans are planted in alternating patterns comprising soybean areas and corn rows, each said soybean area and said corn row comprising a predetermined lateral width.

(Withdrawn) Claim 8. The improved intercropping and mulching method as described in Claim 7, wherein said annual green manure crop comprises buckwheat.

(Currently amended) Claim 9. An improved intercropping and mulching method comprising:

(1) planting an annual green manure crop in the soil of a predetermined area;

(2) mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue to form combined green manure, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area, said first portion of said combined green manure being mechanically collected and mechanically chopped and thereby becoming a combination mulch,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure, said combination mulch being stored during said intercropping,

(4) thereafter spraying said first portion of said combination mulch upon said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two commercial crops, said annual green manure crop and said organic residue protecting said soil of said predetermined area during the winter,

one of said at least two commercial crops comprising a legume,

one of said two commercial crops further comprising soybeans,

one of said at least two commercial crops comprising corn,

said at least two commercial crops comprising corn and soybeans,

there being no intercropped plants other than said at least two commercial crops comprising corn and soybeans,

said corn and said soybeans planted in alternating patterns comprising corn rows and soybean areas respectively, each said soybean area and said corn row comprising a predetermined lateral width,

said annual green manure crop selected from the group consisting of wheat, Austrian peas, hairy vetch, soybeans, annual rye grass and winter rye.

(Not entered) Claim 10. The improved intercropping and mulching method as described in Claim 9, wherein said annual green manure crops are mowed with a conventional mechanical forage harvester.

(Currently amended) Claim 11. The improved intercropping and mulching method as described in Claim 10,
wherein said combination mulch is sprayed upon said soil of said predetermined area after blending and chopping of said green manure plants and organic debris within a bale chopper.

(Not entered) Claim 12. The improved intercropping and mulching method as described in Claim 11 wherein said intercropped soybeans are planted simultaneously with said intercropped corn by using a fork lift attachment with two forks, front end loader and tractor, corn planter, and a modified seed drill, said modified seed drill and said fork lift attaching to said tractor by said front end loader, said fork lift attachment elevated with a hydraulic lift and a retrofit adapter.

(Not entered) Claim 13. The improved intercropping and mulching method as described in Claim 12 wherein said corn planter deposits said corn seeds between previously planted said soybean areas, said soybean areas consisting of soybean subrows, said

soybean subrows deposited by said modified seed drill attached to [said] a tractor, said corn seeds deposited within straight corn furrows.

(Withdrawn) Claim 14. An improved intercropping and mulching method for corn and soybeans comprising:

(A) planting a commercial legume crop in the soil of a predetermined area during the summer, said commercial legume crop forming organic debris within said soil after harvesting of said commercial legume crop,

(B) no-till planting buckwheat and wheat during the following fall in said soil of said predetermined area, said buckwheat and said wheat growing until the following spring, said buckwheat and said wheat covering said soil during the winter,

(C) mowing said buckwheat and said wheat during said following spring, said mowing accomplished by forage harvester,

a second portion of said buckwheat and wheat forming an annual green manure for said soil of said predetermined area, said organic debris also comprising said second portion,

a first portion of said buckwheat and said wheat forming a combination mulch for said soil, said combination mulch further comprising said organic debris, said first portion being mechanically collected and chopped prior to becoming said combination mulch, said combination mulch being stored in a forage wagon,

(D) creating consecutive corn rows, each said corn row comprising three subrows of soybean seeds within a soybean area, each said corn row further comprising one corn furrow,

(E) seeding said soybean seeds in alternating said soybean areas within said consecutive corn rows by using a modified seed drill and a fork lift with a front end loader and a tractor, said tractor comprising a tractor center,

said modified seed drill comprising sets of three tru-vee openers along a horizontal opener draw bar, said fork lift rigidly attached to said modified seed drill by a first fork and second fork, said forks attaching to said modified seed drill by enclosing one set of said tru-vee openers, said modified seed drill aligned with said tractor so said soybean seeds deposit directly beneath and anterior to said tractor center,

(F) seeding said corn seed with a corn planter attached posterior to said tractor, said corn planter creating said corn furrows within said soil corn, said corn furrows containing linearly deposited said corn seeds, said corn furrows spaced laterally from each other approximately 30 inches, said soybean subrows located approximately midway between two consecutive said corn furrows,

(G) covering said seeded soil with said combination mulch, said first portion of said green manure plants and organic debris placed within a forage box wagon prior to chopping within said bale chopper to form said combination mulch, said combination

mulch sprayed onto said soil of said predetermined area with a hose attached to a bale chopper mounted to said forage box wagon.

(Currently amended) Claim 15. The method described in Claim 7 wherein soybean seeds are planted at approximately eight to twenty seeds per square foot of said soil and corn seeds are planted at approximately one corn seed per eight linear inches of said soil, said soybean seeds planted during the same pass across said preselected soil as said corn seeds.

(Currently amended) Claim 16. The method described in Claim 7 wherein a modified seed drill comprises eight sets of tru-vee openers and one center bar, a single said set of said tru-vee openers fitting between first and second forks, said single set of tru-vee openers positioned immediately proximal to either side of said center bar, each said first and second fork resting upon an opener draw bar on either side of said single said set of said tru-vee openers, each said first and second fork attached to said opener draw bar by a clamp.

(Currently amended) Claim 17. The method described in Claim 7 wherein three soybean subrows comprising a soybean area are approximately 21 inches in total lateral width.

(Currently amended) Claim 18. The method as described in Claim 7 wherein rotating augers pull said organic debris and said green manure plants from said forage box wagon into a bale chopper, said bale chopper attaching to a discharge opening by sliding said

bale chopper until interior surfaces of a bale tube fit snugly over exterior surfaces of panels of an attached forage box wagon.

(Currently amended) Claim 19. The method as described in Claim 16 wherein said true-vee openers are arranged in said sets of three, thereby leaving lateral space between each said set along said horizontal bar, each said set seeding soybeans within said three said soybean subrows when said modified seed drill is pulled by a tractor, each said lateral space resulting in unseeded soil, said unseeded soil then seeded with said corn seed within said corn furrows while said corn planter is pulled by said tractor, said seeding of said corn seed and said soybean seed occurring with said modified seed drill and corn planter operatively attached to said tractor.

(Currently amended) Claim 20. The method as described in Claim 19 wherein said two sides of a bale tube attach to said bale chopper, said two sides of said bale tube snugly fitting over an anterior and posterior panel, said anterior and posterior panels surrounding said augers of said forage box wagon, said sides of said bale tube mechanically attached to said anterior and posterior panels, said forage box wagon physically attaching to a bale chopper main frame with L-brackets, said green manure plants and organic debris chopped within said bale chopper main frame after passing said augers.

EVIDENCE APPENDIX

Not applicable.

Exhibit A

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/747,728	12/29/2003	Marvin J. Williams JR.		2033

31156 7590 03/22/2005

LAW OFFICE OF ADRIENNE B. NAUMANN
8210 NORTH TRIPP
SKOKIE, IL 60076

EXAMINER	
GELLNER, JEFFREY L	

ART UNIT	PAPER NUMBER
3643	

DATE MAILED: 03/22/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.	Applicant(s)	
10/747,728	WILLIAMS, MARVIN J.	
Examiner	**Art Unit**	
Jeffrey L. Gellner	3643	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *27 December 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) *8 and 14* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7 and 9-13* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

The intercropped commercial crops are exclusively soybeans and corn. *Id.*, page 8, lines 24-28; page 44, lines 11-12. The farmer plants the soybeans and corn in alternating soybean areas and corn rows, with each area and row having a predetermined width. *Id.*, page 26, lines 5-10, page 27, and page 28 lines 1-4.

DETAILED ACTION

Specification

The disclosure is objected to because of the following informalities:

A"Cross Reference" section should be clearly differentiated. And, 10/683,889 and 09/752,956 should show the dates these applications were filed.

In the "BRIEF DESCRIPTION OF THE DRAWINGS" section the term "wheat grass" should probably be --wheat-- so as to not be confused with wheatgrass, *Agropyron* spp. The term "wheat grass" is used occasionally in the Specification and should be changed to --wheat--.

Appropriate correction is required.

Election/Restrictions

Applicant's election of Invention I, Species B, in the reply filed on 27 December 2004 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)). Claim 14 is withdrawn because it is drawn to the non-elected invention; claim 8 is withdrawn because it is drawn to the on-elected species.

Claim Objections

Claim 1 is objected to because of the following informalities:

In claim 1, line 4, Examiner questions whether the term "harvested" is proper in this context. Possibly, -chopping--, --mowing--, or --cutting-- would be more precise.

In claim 1, lines 12-13, "said first commercial crop and second commercial crop" should probably be --said at least two commercial crops-- to conform with prior language in the claim.

In claim 1, line 14, "said commercial crops" should probably be --said at least two commercial crops-- to conform with prior language in the claim.

In claim 1, lines 15-16, "said intercropped commercial crops" should probably be --said at least two commercial crops-- to conform with prior language in the claim.

In claim 1, lines 16, "said green manure crop" should probably be --said annual green manure crop-- to conform with prior language in the claim.

In claim 1, line 16, "organic debris" should probably be --said organic residue-- to conform prior language in the claim.

In claims 2 and 3, lines 1-2, "said first intercropped commercial crop" should probably be --one of said at least two commercial crops-- to conform with prior language in claim 1.

In claim 4, lines 2 and 3, "said intercropped commercial crop" should probably be --one of said at least two commercial crops-- to conform with prior language in claim 1.

In claim 5, lines 15-16, "two said commercial crops" should probably be --said at least two commercial crops-- to conform with prior language in the claim 1.

The above objections are given as examples. Applicant should check the remaining claims for conformity of language. Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1 and 10-13 is rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 1, line 11, the step (4) of "dispersing said first portion" is indefinite because it is unclear how dispersing can be achieved after the intercropping step. Would not the green manure be dispersed during harvesting of this crop?

In claim 1, line 11, "said first portion of said combined mulch" lacks antecedent basis. It should probably be --said first portion of said combined green manure--.

In claim 10, line 2, the term "conventional mechanical forage harvester" is indefinite because there is no objective standard to determine which forage harvesters are conventional.

In claim 11, line 2, the term "combination green manure" lacks antecedent basis.

In claim 12, lines 3 and 4, the terms "conventional corn planter" and "conventional seed drill" are indefinite because there is no objective standard to determine when these machines are conventional.

In claim 13, line 4, "prior art tractor" lacks antecedent basis.

Claim Rejections - 35 USC §103

The following is a quotation of 35 U.S.C. §103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-7 and 10 are rejected under 35 U.S.C. §103(a) as being unpatentable over Iragavarapu et al. (Journal of Production Agriculture) in view of Lu et al. (J. of Sustainable Agriculture).

As to claim 1, Iragavarapu et al. disclose the method of using intercropping of at least two commercial crops ("corn" and "soybean" from abstract). Not disclosed is the use of an annual green manure crop in a predetermined area. Lu et al., however, disclose an annual green manure crop ("winter annual cover crop" from abstract) planted in a predetermined area (the field where crops are grown) and harvesting the annual green manure crop (in that the cover crop is harvested before the planting the commercial spring-planted crop), the annual green manure crop would have two portions (in that the leaves are the first portion and the stems the second portion of any plant) and would combine with the organic residue of the soil to form a combined green manure, whereby, the combined green manure would provide nutrients to the at least two commercial crops and provide ground cover. It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method Iragavarapu et al. by adding the use of a annual green manure crop as disclosed by Lu et al. so as to increase profitability of the farming system (see Lu et al. at abstract).

As to claims 2 and 3, Iragavarapu et al. as modified by Lu et al. further disclose one of the intercropped crops as soybean (see abstract of Iragavarapu et al.).

As to claim 4, Iragavarapu et al. as modified by Lu et al. further disclose the other commercial crop as corn (see abstract of Iragavarapu et al.).

As to claim 5, Iragavarapu et al. as modified by Lu et al. further disclose the intercropped commercial crop as soybeans and corn (see abstract of Iragavarapu et al.).

As to claim 6, Iragavarapu et al. as modified by Lu et al. further disclose the intercropped commercial crop as soybeans and corn (see abstract of Iragavarapu et al. in that the beginning of the abstract states that strip-cropping only corn and soybean is a regular procedure).

As to claim 7, Iragavarapu et al. as modified by Lu et al. further disclose the intercropped commercial crop as soybeans and corn in alternating patterns of areas of rows (see abstract of Iragavarapu et al.).

As to claim 10, the limitations of Claim 7 are disclosed as described above. Not disclosed is the green manure crop mowed with a conventional mechanical forage harvester. It would have been obvious to one of ordinary skill in the art at the time of the invention to further modify the method of Iragavarapu et al. as modified by Lu et al. by using a conventional mechanical forage harvester since this is a known regular farming practice.

Allowable Subject Matter

Claim 9 and 11-13 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Ghaffarzadeh discloses in the prior art rotation where wheat can be considered a green manure crop for the next crop. Williams Jr discloses a patent from the instant inventor.

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Jeffrey L. Gellner whose phone number is 703.305.0053 (after 4 April 2005 use: 571.272.6887). The Examiner can normally be reached Monday through Thursday from 8:30 am to 4:00 pm. The Examiner can also be reached on alternate Fridays.

If attempts to reach the Examiner by telephone are unsuccessful, the Examiner's Supervisor, Peter Poon, can be reached at 703.308.2574. The official fax telephone number for the Technology Center where this application or proceeding is assigned is 703.872.9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703.308.1113.

Jeffrey L. Gellner
Primary Examiner

Notice of References Cited	Application/Control No. 10/747,728	Applicant(s)/Patent Under Reexamination WILLIAMS, MARVIN J.	
	Examiner Jeffrey L. Gellner	Art Unit 3643	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-6,631,585	10-2003	Williams, Jr., Marvin J.	47/58.1R
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Iragavarapu et al. 1996. Border effects on yields in a strip-intercropped soybean, corn, and wheat production system. Journal of Production Agricultural 9: 101-107.
	V	Lu et al. 1999. Economic analysis fo sustainable agricultural cropping systems for Mid-Atlantic states. Journal of Sustainable Agriculture 15: 77-93.
	W	Ghaffarzadeh. 1997. Economic and biological benefits of intercropping berseem clover with oat in corn-soybean-oat rotations. Journal of Production Agricultural 10: 314-319.
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

ticle Title: Economic and biological benefits of intercropping berseem clover with oat in corn-soybean-oat rotations.

ıthor: Ghaffarzadeh, M.

ɔurce Info: Journal of production agriculture. J. prod. agric. Apr/June 1997. v. 10 (2)
p. 314-319.
ISSN 0890-8524; JPRAEN

:all Number S539.5.J68

ıbstract: Sustainability of Iowa agriculture may require change from predominantly a corn (Zea mays L.)-soybean [Glycine max (L.) Merr.] rotation to more diverse cropping systems. Alternative crops are vital for providing temporal diversity. Reincorporating small grains into a thin-crop rotation with corn and soybean can provide greater temporal diversity, especially if a forage legume is included as a companion crop. A field study was established in 1991 on a Kenyon (fine-loamy, mixed, mesic Typic Hapludoll) soil to evaluate the economic and biological benefits of an oat (Avena sativa L.) crop underseeded with berseem clover (Trifolium alexandrinum L.) in a three crop-rotation. Two rotation treatments were compared: (i) corn-soybean-oat and (ii) corn-soybean-oat intercropped with berseem clover. In 1992, 1993, 1994, and 1995, oat grain yield was not significantly changed when berseem clover was underseeded with the oat crop. However, in 5 yr, oat underseeded with berseem clover produced up to 70% more biomass (harvested material without the grain) than sole-crop oat straw. The biomass (40% oat straw and 60% berseem clover forage) also had adequate digestible material (51%) to be considered as low quality forage. Berseem clover regrowth after oat grain harvest produced an average 1.2 tons/acre of forage, which could have been harvested for hay or left in the field as green manure. During this trial, berseem clover regrowth was left as groundcover and green manure, which contributed an average of 39 lb N/acre to the succeeding corn crop. Corn grain yields following berseem clover were 10% higher over the trial period. Soybean grain yields were the same for both treatments. Intercropping berseem clover with oat returned an average of $39/acre more than sole-crop oat. This study demonstrated both economic and biological advantages for more diverse cropping practices.

Bibliography Note: Includes references

NAL Subject(s):
Zea mays
Glycine max
Avena sativa
crop rotation
Trifolium alexandrinum
intercropping
crop yield
legumes
regrowth
green manures
nitrogen
soil fertility

economic analysis
grains

NAL Geographic(s): Iowa

Other Subject(s): nutrient sources
ground cover
biomass production
sole cropping
companion crops
undersowing
sole cropped versus intercropped oat

Subject Code(s): J700
F120
F600
F500
E200

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National Agricultural Library
Beltsville, MD 20705
301-504-5755
agref@nal.usda.gov

Article Title: Ec omic analysis of sustainable agricultural cropping systems for Mid-Atlantic states.

Author: Lu, Y.C.

Other Author(s): Watkins, B.
Teasdale, J.

Source Info: Journal of sustainable agriculture. J. sustain. agric. 1999. v. 15 (2/3)
p. 77-93.
ISSN 1044-0046; JSAGEB

Call Number S494.5.S86S8

Abstract: This paper evaluates the profitability and economic risks associated with four cropping systems for the Sustainable Agriculture Demonstration site at Beltsville, Maryland, for the 1994-97 period. Each system follows a 2-year rotation of corn in the first year and winter wheat and soybean in the second year. The four systems are (1) a no-tillage system with recommended fertilizer and herbicide inputs, (2) a no-tillage system with crownvetch living mulch, (3) a no-tillage system with winter annual cover crop, and (4) a reduced tillage manure-based system without chemical inputs. The cover crop system is the most profitable ($238 in gross margin), closely followed by the no-tillage ($233) and the manure-based system ($217). Even though farmers desire a cropping system that maximizes profits, the variability of profits, or risks, can influence the desirability of the cropping system. In terms of risks, no-tillage is the most preferred rotation with the smallest coefficient of variation (1.14) followed by the cover crop system (1.24), the manure-based system (1.58), and the crownvetch system (5.45). The same ranking can be obtained using a "safety-first" criterion for risk-averse farmers, in which the gross margin of the no-tillage system would exceed $53 ha(-1) in three out of four years, while the gross margin of the cover crop system would exceed $39 ha(-1) in three out of four years. The manure-based system is an organic system and it was not profitable in 1996 and 1997 because of weed infestations. However, the manure-based system shows potential to be the most profitable if some methods can be found to control weeds without resorting to herbicides and its crops can be certified as organic and sold at premium prices.

Bibliography Note: Includes references

NAL Subject(s): cropping systems
economic analysis
profitability
risk assessment
crop rotation
Zea mays
Triticum aestivum
Glycine max
no-tillage
green manures
cover crops
conservation tillage

Subject code(s): J700
F120

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National Agricultural Library
Beltsville, MD 20705
301-504-5755
agref@nal.usda.gov

Article Title: terseeding cover crops into soybean and subsequent corn yields.

Author: Hively, W.D.

Other Author(s): Cox, W.J.

Source Info: Agronomy journal. Agron. j. Mar/Apr 2001. v. 93 (2) p. 308-313.
ISSN 0002-1962; AGJOAT

Call Number 4 AM34P

Abstract: Organic producers in the northeastern USA have difficulty establishing cover crops after soybean [Glycine Max (L.) Merr.] harvest. We interseeded species into soybean on an organic farm without livestock to identify cover crops that do not interfere with soybean harvest, provide significant ground cover, and increase subsequent corn (Zea mays L.) yields. Foenugreek (Trigonella foenum-graceum L.), rye (Secale cereale L.), wheat (Triticum aestivum L.), strawberry clover (Trifolium fragiferum L.), and Austrian winter pea (Dolichos lignosus L.) did not meet establishment and height requirements at the time of harvest. White clover (Trifolium repens L.), red clover (Trifolium pratense L.), barrel medic (Medicago lupulina L.), alfalfa (Medicago sativa L.), annual ryegrass (Lolium multiflorum L.), and creeping red fescue (Festuca rubra L.) met these requirements and generally provided >30% ground cover. Interseeded grasses provided the most biomass (0.5-1.1 Mg ha-1) at spring plowdown. Interseeded legumes did not establish well in 1996-1997 and produced only 0.1 to 0.2 Mg ha-1 biomass in 1997. Corn yielded more following Dutch white clover (7.2 Mg ha-1) and medium red clover (6.7 Mg ha-1) than following no cover (5.7 Mg ha-1) in 1996 but yielded the same in 1997 (5.7, 6.3, and 6.2 Mg ha-1, respectively). Corn yielded less following annual ryegrass (5.3 Mg ha-1) and creeping red fescue (5.1 Mg ha-1) than following no cover in 1997. More research is needed to identify conditions that would reduce the risk of poor establishment of interseeded legumes or reduced corn yields following interseeded grasses.

ibliography Note: Includes references

AL Subject(s): Zea mays
Glycine max
cover crops
intercropping
organic production
crop yield
grasses

L Geographic(s): New York

ner Subject(s): biomass production
performance
establishment
plant height
ground cover

strip cropping
intercropping
interspecific competition
soil water
crop yield
moisture content
grains

NAL Geographic(s): Minnesota

Other Subject(s): border effects
row orientation

Subject Code(s): J700
F120
F300
F600

==========

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National Agricultural Library
Beltsville, MD 20705
301-504-5755
agref@nal.usda.gov

Article Title: B[illegible]er effects on yields in a strip-intercropped soybean, [illegible]corn, and wheat production system.

Author: Iragavarapu, T.K.

Other Author(s): Randall, G.W.

Source Info: Journal of production agriculture. J. prod. agric. Jan/Mar 1996. v. 9 (1)
p. 101-107.
ISSN 0890-8524; JPRAEN

Call Number S539.5.J68

Abstract: Strip-intercropping of corn (Zea mays L.) and soybean [Glycine max (L.) Merr.] normally results in corn producing a negative border effect on soybean production. This study was conducted to determine whether including a small grain strip between corn and soybean strips could reduce the negative border effects of corn and enhance soybean yields. Corn, soybean, and wheat (Triticum aestivum L.) were grown as strip intercrops (15-ft wide) in a ridge-till system at two locations in southern Minnesota from 1991 through 1994 and were compared with a two-crop corn-soybean system. Rows were oriented east-west at one location and north-south at the other. Soybean yield in the three-crop system was reduced by 17% for the north row adjacent to corn and 8% for the south row next to wheat compared with nonborder east-west rows. In north-south rows, soybean yields were reduced by 21% in the east row next to corn compared with nonborder rows with no yield reduction in the west row next to wheat. In the two-crop corn-soybean strip system, soybean yields were reduced by 34 and 11% in the south and north border rows, respectively, compared with the nonborder rows in east-west rows. In north-south rows, the outside east row yielded 19% less and the west row yielded 21% less than the nonborder rows. Corn yield of the outside north row next to wheat in east-west rows was 6% greater while the south row next to soybean yielded 18% greater than the nonborder rows. In north-south rows, the east outside row next to wheat yielded 23% greater and the west row next to soybean yielded 27% greater than the nonborder rows. In the two-crop system, yield of the outside corn rows was enhanced similarly compared with the nonborder rows in both row orientations. Wheat yield in the 5-ft section next to soybean was 4% greater than the center 5-ft section and 6% greater than the 5-ft section next to corn in east-west rows and 9 and 17% greater in north-south rows. Results from this 4-yr study indicate that wheat planted between corn and soybean strips improved soybean production over the two-crop system without adversely affecting wheat yields. Corn production was enhanced by 9 to 12% in north-south rows and 2 to 7% in east-west rows in both the two- and three-crop strip systems.

.bliography Note: Includes references

L Subject(s): Glycine max
Zea mays
Triticum aestivum

Sec[illegible]gera varia
fertilizers
herbicides
Vicia
cattle manure

NAL Geographic(s): Maryland

Other Subject(s): evaluation
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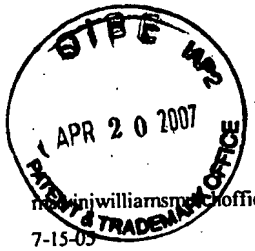

IN THE UNITED STATES OFFICE OF PATENTS AND TRADEMARKS
PATENTS

Re:

Inventor and Applicant: Marvin J. Williams, Jr.

Application No. 10/747,728

Filing Date: December 29, 2003

Art Unit: 3643

Examiner: Jeffrey L. Gellner

OFFICE ACTION REPLY

Assistant Commissioner for Patents

U.S. Office of Patent and Trademarks

P.O. Box 1450

Alexandria, Virginia 22313-1450

Dear Sir or Madam:

In response to the Office Action of March 22, 2005 please amend the above captioned application as follows:

Changes to the Specification begin on page 2 of this paper.

Changes to the Claims begin on page 14 of this paper.

The Brief begins on page 24 of this paper.

The Remarks begin on page 51 of this paper.

The Appendix is attached to the end of this paper, and it contains photocopies of the full text of research articles on which the government relies.

IN THE SPECIFICATION

Please amend the following paragraphs as follows:

(65) My intercropping and mulching method 110 resolves the long–felt need to intercrop economically while preserving the soil for the long term. The following steps comprises [[In]] the best mode of my process 110~~, the following comprises~~ in most basic format, and without additional artificial pesticides, fertilizers and herbicides:

(i) no-till planting of green manure plants 44a during the fall within soil 45 of a predetermined area which contains organic debris 19,

(ii) harvesting a portion of the green manure plants 44a for mulch 20;

(iii) quick tilling a portion of green manure plants 44a and organic debris 19 into the soil 45 of this predetermined area the following spring, and

(iii) intercropping of commercial crops, including at least one legume, immediately thereafter within the same predetermined soil, and

(iv) spreading a layer of combination mulch 20, also comprising green manure plants 44a and organic debris 19, over the surface of the intercropped seeded soil 45.

Please amend paragraph 68 as follows:

(68) My preferred method of combined intercropping and mulching 110 provides best results in a midwestern climate. The preferred soils are typical of southwestern lower Michigan and northern Indiana, especially Berrien County in Michigan and LaPorte County in Indiana. Crops are preferably planted in rimer loamy fine sand soils, above a river or drainage way. Soils such as rimer are easily washed away, so my combined method [[101]] 110 is particularly useful in these areas. However, method [[101]] 110 is

also beneficial upon other farmland, as well as irrigated fields. Intercropping and green manure growth is optimal when soil 45 is planted the previous growing season with commercial soybeans 16c.

Please amend paragraph 93 as follows:

(93) In the best mode of my invention 110, a conventional seed drill 96 is modified to plant an approximately 21-inch wide area 9 of soybean seeds 12, between linearly planted corn seed 10. The modified seed drill 96 preferably leaves alternating intervening unplanted areas 8b which are then seeded with a conventional corn planter 95. Figure 8.

Please amend paragraph 100 as follows:

(100) Referring now to Figure 10, the preferred modified seed drill 96 is approximately twenty feet in width. The linear distance along opener draw bar 147 from right exterior edge 160a to drill center frame 149 is approximately ten feet, as is the distance between left exterior edge 160b and drill center frame 149. On either side of drill center frame 149 are four sets 151 of three tru-vee openers 150, 152, 153. Each tru-vee opener 150, 152, 153 opens soil 45 with first and second disk blades 154a, 154b. Blades 154a, 154b are angled to each other, thereby forming a "v" with an apex at the point closest to soil 45. As tru-vee openers 150, 152, 153 move forward, blades 154a, 154b turn and cut into soil 45, creating a v-shaped indentation. A seed tube 158 is positioned centrally between both blades to deposit seeds within each v-shaped soil indentation.

Please amend paragraph 102 as follows:

(102) As seen in ~~Figures 10 and~~ Figure 12, third frame 148 lies above tru-vee openers 150, 152, 153, and comprises opener springs 170. Third frame 148 holds each opener spring 170 in place above each corresponding tru-vee opener 150,152 or 153, as the case may be. Each opener spring 170 presses downward on its corresponding tru-vee opener 150, 152, 153, thereby providing stabilization over a hard soil surface. Each opener spring 170 presses its corresponding tru-vee opener 150, 152, 153 into soil 45 in the same manner as prior art seed drills.

Please amend paragraph 103 as follows:

(103) Referring to Figures 10 and 12, each opener spring 170 also has an upper U-clamp 180 which attaches each opener spring 170 to third frame 148 with first and second nuts 150c, 150d respectively. When nuts 150c, 150d and bolts 150a, 150b are removed, a person can manually slide each tru-vee opener 150, 152, 153 horizontally along ~~oepner~~ opener draw bar 147 and third frame 148. Each tru-vee opener 150, 152, 153 also comprises [[a]] single seed tube 158 which connects each corresponding tru-vee opener 150, 152 or 153 to seed bin 159 in a manner well known in the agricultural industry.

Please amend paragraph 108 as follows:

(108) Referring now to Figures 12 and 15B (posterior view of seed drill 96), in both the prior art and my modified seed drill 96, each row cover unit 140 comprises two wheels 140a, 140b which connect to row cover unit frame 206. Each row cover unit 140 corresponds to a single tru-vee opener 150, 152 or 153 which is anterior to that row cover unit 140 ~~(also in the prior art and my invention 110)~~. Each row cover unit 140 also comprises a corresponding spring 170a which attaches row cover unit 140 to footboard 143.

Please amend paragraph 115 as follows:

(115) Still referring to ~~Figure~~ Figures 14 and 15A, the user mounts fork lift attachment 203 [[on]] upon tru-vee opener set [[151]] 150, 152, 153 which is immediately to the left or right of center support frame 149. In the appended figures, forklift attachment 203 is mounted to right side 160b so that a single tru–vee opener 152 is directly anterior to tractor center 97c. In this manner the farmer can mount seed drill 96 to tractor 97 at one of two positions, as long as front end loader 200 is positioned upon one center set 151 of tru-vee openers 150, 152,153.

Please amend paragraph 119 as follows:

(119) Referring now to Figures 13 and 15A, [[The]] the preferred prior art front end loader 200 comprises first, second, third and fourth hydraulic cylinders 205a, 205b, 205c, 205d (generically 205) operated by an interior tractor oil pump. First and second hydraulic cylinders 205a, 205b respectively are positioned upon front end loader posterior 200b; they raise and lower front end loader 200 with fork lift attachment 203. The remaining third and fourth hydraulic cylinders 205c, 205d respectively pivot prior art retrofit adapter 206 on front end loader anterior 200a by hooks 92.

Please amend paragraph 120 as follows:

(120) ~~Still referring~~ Referring to Figure 12, retrofit adapter 206 fits within slots 46a [[on]] upon bars 46b ~~within~~ of prior art fork lift attachment 203; retrofit adapter 206 thereby connects fork lift attachment 203 to front end loader 200 (not seen in this view). Retrofit adapter 206 moves with hydraulic cylinders 205c, 205d whenever fork lift 203 is mounted to retrofit adapter 206, thereby pivoting fork lift attachment 203. This arrangement of retrofit adapter 206 with hydraulic cylinders 205c, 205d and fork lift

attachment 203 allows the farmer to level seed drill 96 [[when]] whenever modified seed drill 96 is attached to forks 202a, 202b.

Please amend paragraph 123 as follows:

(123) Prior to mounting seed drill 96 to fork lift 203, fork 202a must slide alongside center frame 149 on seed drill side 96a. As seen in Figure 15A one set 151 of tru-vee openers 150, 152, 153 respectively fits between forks 202a, 202b. The farmer then attaches forks 202a, 202b to opener draw bar 147 with first and second U-clamps 208a, 208b respectively, as best seen in Figure 12A. Prior art unmodified seed drill 96 only deposits one row of soybean seeds 12 to the left and right of tractor center 97c. However, as seen in Figure 15A, in my invention 110 there are four sets 151 of three tru-vee openers 150, 152, 153 on either side of center support frame 149. Now the farmer can attach modified seed drill 96 to forklift 203, so one tru-vee opener 152 is positioned directly anterior to tractor center 97c.

Please amend paragraph 127 as follows:

(127) A John Deere 541 Series Loader 200 with attached forklift 203 is the preferred front end loader and forklift of choice. However other front end loaders 200 and forklifts 203 are satisfactory, depending upon compatibility with a farmer's equipment. As seen in Figure 13, front end loader 200 pushes seed drill 96 while corn planter 95 follows behind tractor 97 and linearly deposits corn 10 within corn furrows 90. Referring to Figure 14, in the best mode the farmer attaches corn planter 95 to tractor 97 posterior, using a three point hitch [[230a]] or a one point tug hitch [[230b]] 230, both of which are familiar to the agricultural industry.

Please amend paragraph 128 as follows:

(128) With a conventional front end loader 200 and a coupled conventional forklift 203, a farmer intercrops at least two plants simultaneously, thereby saving time, machine fuel and labor. In other modes modified seed drill 96 is towed by a first tractor 97, while a second tractor pulls [[with]] attached corn planter 95[[,]] and ~~which~~ closely follows the first tractor 97 with modified seed drill 96. Whether modified seed drill 96 or corn planter 95 proceeds the other is not crucial, if no significant time passes between corn and soybean seedings.

Please amend paragraph 129 as follows:

(129) Referring to ~~Figure~~ Figures 11 and 14, the farmer plants corn seeds 10 linearly within furrows 90 with a ~~prior art~~ mechanical corn planter 95, which is [[(]] preferably a KINZIE 3100 corn planter[[)]](not seen). Each corn planter 95 has row units 162 which open soil to create corresponding corn furrows 90. Each row unit 162 also places corn seed 10 within its corresponding corn furrow 90. As corn planter 95 moves forward, each corresponding row cover unit 162a covers its furrow 90 with soil 45.

Please amend paragraph 130 as follows:

(130) Referring to Figure 14, there are eight row units 162 (not all seen in this view) which horizontally align upon corn planter 95, and with corn planter 95 posteriorly attached to tractor 97. Each row unit 162 mechanically opens each furrow 90 and deposits corn seed 10a. Corn planter row units 162 are adjustable for linear intervals of seed deposit location, as well as seeding to a pre-determined depth. With my method 110, each row unit 162 deposits a corn seed 10a every eight linear inches, ~~while~~ and row cover unit 162a then covers seeds 10 with soil 45.

Please amend paragraph 131 as follows:

(131) After the farmer has intercropped and applied combination mulch 20 (described *infra*) to the first twenty-foot wide area of soil 45, he tills soil 45 and combination green manure 44 for an additional eight corn rows 8 (i.e., another approximate twenty feet lateral width) adjacent to the preceding intercropped twenty-foot wide area. This incremental process continues for each twenty-foot wide pass comprising eight consecutive furrows 90 which are separated by 30-inch corn row 8. In the best mode the operator uses a JOHN DEERE 520 seed drill 96 with a twenty-foot plant path width, and a ~~an unmodified prior art~~ corn planter 95 with an approximate twenty-foot pass width. However, if the operator uses a four row corn planter 95, he only tills that much soil 45 within four corn rows 8 of one pass.

Please amend paragraph 132 as follows:

(132) Other means of intercropping commercial plants are also within the scope of my invention for larger commercial fields. For small gardens, the farmer uses a conventional manual leaf rake 99 to distribute soybean seed 12 randomly within each approximately twenty- inch wide soybean area 9. With either the manual method or mechanized approach, soybean seeds 12 are planted approximately two to three inches deep into soil 45.

Please amend paragraph 133 as follows:

(133) In the best mode mowed green manure plants 44a, corn stalks 5 and other organic debris 19 remaining after the fall harvest are collected similarly to conventional forage: A forage feed harvester harvests and blows mowed green manure plants 44a and debris 19 into forage box wagon 51. Please see ~~Figure~~ Figures 18 and 20. In my invention 110,

initial blending of combination mulch 20 results from mowing and blowing of severed green manure plants 44a and debris 19 into forage wagon 51.

Please amend paragraph 136 as follows:

(136) The preferred ~~prior art~~ forage box ~~wagons~~ wagon 51 for temporarily storing large amounts of combined chopped mowed wheat grass 18a and organic debris 19 is available from:

H&S Manufacturing Co., Inc.

2608 South Hume Avenue

P.O. Box 768

Marshfield, Wisconsin 54449

Telephone: 1-715-387-3414

Models: HD7+4 & HD Twin Auger;

HD7+4 HDTwin Auger-front and rear unload; and

power box-rear unload

Please amend paragraph 137 as follows:

(137) For smaller amounts of wheat grass 18a and organic debris 19, preferred Versa Vac ~~storage~~ forage box wagons (conventionally used for grass clippings and leaf pick-up) are available from:

Fuerst Brothers, Inc.

P.O. Box 427

Gibson City, Il.

1-800-435-9630,

Models: M180G, M500P, M500G, M900P, M900G

Fuerst Manure Spreaders are also satisfactory and are distributed by:

H.F.S. Tractor

1218 South 11th Street

Niles, Michigan

1-616-683-7272

Please amend paragraph 138 as follows:

(138) Unload augers 215a, 215b and discharge opening 137 comprise a cover or lid in the prior art. Attachment of ~~conventional~~ forage box wagons 51 to forage harvesters is already routine for harvest and storage of forage feed. However, my method 110 introduces a new manner to produce combined mulch 20 from green manure 44 and organic debris 19 in forage box wagon 51. In this process, the farmer operatively attaches bale chopper 108 to the side of forage box wagon 51 around first and second unload augers 215a, 215b respectively, *infra*. Figures 17 and 19. My method 110 eliminates manual labor for filling bale chopper 108 in the prior art. In addition, my remounted pipe 230a and hose 230b spray combination mulch 20 over the intercropped seeded field in a manner well known in this agricultural industry. Please see Figure 16.

Please amend paragraph 139 as follows:

(139) Prior to intercropping the farmer attaches preferred gasoline powered prior art bale chopper 108 to forage box wagon 51. First and second unload augers 215a, 215b

respectively are located within discharge opening 137 along the anterior lateral exterior surface of forage box wagon 51. Please see Figures 17, 18. On either side of each first and second unload auger 215a, 215b are rear extension panel st17 and anterior extension panel st18 respectively. Power take off (PTO) 165 is a prior art drive shaft at tractor posterior 97e which connects to a second drive shaft on forage box wagon 51. When functionally connected, PTO 165 transfers power from tractor 97 to forage box wagon 51 to operate both unload augers 215a, 215b.

Please amend paragraph 140 as follows:

(140) In my invention 110, organic debris 19 and green manure plants 44a are pulled from prior art forage box wagon 51, through rotating augers 215a, 215b and beaters 36 located above augers 215a, 215b. Figure 18. Using prior art t-rod slats attached to chains (not seen) on the floor of forage box wagon 51, green manure 44 is pulled to the forage wagon anterior. Rotating unload augers 215a, 215b propel organic debris 19 and green manure plants 44a through discharge opening 137 into bale chopper 108, while plastic guard 169 protects the farmer from injury during operation. Figure 17.

Please amend paragraph 141 as follows:

(141) Referring now to Figure [[19]] 17, unload augers 215a, 215b do not physically connect to bale chopper 108 in any manner. Instead, blended organic debris 19 and green manure plants 44a move through discharge opening 137 around augers 215a, 215b and then into bale tube 76, prior to entering bale chopper main frame 130. Bale tube 76 holds organic debris 19 and green manure plants 44a, until main frame knife blades 175a rotate and chop organic debris 19 and plants 44a, thereby creating combination mulch 20.

Please amend paragraph 142 as follows:

(142) As best seen in Figure 17, front and posterior panels st17, st18 respectively form first and second parallel walls of discharge opening 137. To attach bale chopper 108 to discharge opening 147, the farmer slides bale chopper 108 along panel st17, st18 exterior surfaces until interior surfaces of bale tube 76 snugly fit over exterior surfaces of ~~panes~~ panels st17, st18. The farmer next drills two ½ inch diameter circular apertures 240a, 240b (using a conventional power drill and a ½ inch drill bit) through anterior edges 17a, 18a of each corresponding extension panel st17, st18. Each pair of apertures 240a, 240b is located approximately four inches above the bottom of ~~either~~ corresponding extension panel st17, st18. He also drills similar apertures 241a, 241b through both posterior edges 76a, 76b respectively of bale tube 76.

Please amend paragraph 143 as follows:

(143) The farmer then places a first two–inch long by ½ inch thick auger ~~bolts~~ bolt 225a through apertures 240a, 241a and an identical second auger bolt 225b through apertures 240b, 241b respectively. He then tightens auger bolts 225a, 225b in place with ~~by prior art~~ washers and nuts (not seen). In this manner, he attaches bale chopper 108 to each front and rear extension panel st18, rear st17 with first and second auger bolts 225a, 225b (i.e., two auger bolts 225 along each corresponding anterior edge 18a, 17a respectively of each front extension panel st18 and rear extension panel st17 respectively).

Please amend paragraph 144 as follows:

(144) Still referring to Figures 17, 19 and 20, the farmer attaches one first and one second main frame L-bracket 220a, 220b respectively to first side stack st8 and second side stack st9 respectively. There are at least four self-taping screws 242 for attachment of each L-bracket 220a, 220b to side stack st8 and side stack st9. Each L-bracket 220a, 220b is

preferably twelve-inches in length by one inch in width, and each self-taping screw 242 is approximately 3/8 inch wide by ½ inch–long. ~~L brackets 220a, 220b attach to both bale chopper main frame 130 and the side of forage box wagon 51 with bale chopper 108.~~

L brackets 220a, 220b attach bale chopper main frame 130 to the side of forage box wagon 51.

Please amend paragraph 146 as follows:

(146) Referring to Figures 19 and 20, the farmer uses four conventional bunge straps 229 to physically attach exhaust hose 230b, by hooking bunge straps 229 to first and second side stacks st7, st8 respectively, as well as third and [[four]] fourth side stacks st10, st11 along forage box wagon 51. Pipe 230a connects bale chopper 108 to hose 230b in a manner well know in this art. Preferably hose 203b is trimmed to spray combination mulch 20 over soil[[.]] 45.

Please amend paragraph 147 as follows:

(147) In smaller fields or gardens, implements such as the 109 BLUEBIRD™ EasyRake are recommended to collect and ~~preferably~~ distribute a smaller quantity of combination mulch 20 over soil 45. The farmer [[then]] manually plants and seeds soil 45 within an area of approximately ten to 20 feet in width. The farmer can then follow seeding with application of combination mulch 20 in the smaller field or garden.

IN THE CLAIMS

(Amended) Claim 1: An improved intercropping and mulching method without artificial herbicides, fertilizer, pesticides and manure, said improved intercropping and mulching method comprising:

(1) no-till planting an annual green manure crop in the soil of a predetermined area;

(2) ~~harvesting~~ mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue from said predetermined area to form combined green manure, said organic residue comprising desiccated intact soybean roots and desiccated intact nitrogen nodules, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area to a depth of approximately nine to fourteen inches, said first portion of said combined green manure becoming a combination mulch, said annual green manure crop remaining unmowed until tillage of said soil,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure,

(4) thereafter ~~dispersing~~ spraying said first portion of said ~~combined~~ combination mulch upon the surface of said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops ~~first commercial crop and second commercial crop,~~

whereby, said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two ~~intercropped~~ commercial crops, said annual green manure crop and said organic residue ~~debris~~ protecting said soil of said predetermined area during the winter.

(Amended) Claim 2. The improved intercropping and mulching method as described in Claim 1, wherein one of said ~~first intercropped commercial crop~~ at least two commercial crops comprises a legume.

(Amended) Claim 3. The improved intercropping and mulching method as described in Claim 1, wherein one of said ~~first intercropped~~ at least two commercial [[crop]] crops comprises soybeans.

(Amended) Claim 4. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn.

(Amended) Claim 5. The improved intercropping and mulching method of Claim 1 wherein one of said at least two ~~said~~ commercial crops comprises ~~comprise~~ corn and one of said at least two commercial crops comprises soybeans.

(Amended) Claim 6. The improved intercropping and mulching method as described in Claim 1, wherein there are no intercropped plants other than said at least two commercial crops ~~a first and second intercropped commercial plants~~, said ~~first and second intercropped commercial plants~~ at least two commercial crops comprising said corn and said soybeans.

(Amended) Claim 7. The improved intercropping and mulching method as described in Claim 6 wherein said corn and said soybeans are planted in [[an]] alternating patterns comprising soybean areas and corn rows, each said soybean area and said corn row comprising a predetermined lateral width.

(Amended) Claim 8. The improved intercropping and mulching method as described in Claim 7, wherein said annual green manure crop comprises buckwheat.

(Amended) Claim 9.

An improved intercropping and mulching method comprising:

(1) planting an annual green manure crop in the soil of a predetermined area;

(2) ~~harvesting~~ mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue to form combined green manure, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area, said first portion of said combined green manure becoming a combination mulch,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure,

(4) thereafter ~~dispersing~~ spraying said first portion of said ~~combined~~ combination mulch upon said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two ~~intercropped~~ commercial crops, said annual green manure crop and said organic residue ~~debris~~ protecting said soil of said predetermined area during the winter,

one of said ~~first intercropped commercial crop~~ at least two commercial crops comprising a legume,

one of said ~~first intercropped~~ two commercial crops further comprising soybeans,

one of said at least two commercial crops comprising corn,

said at least two ~~said~~ commercial crops comprising corn and soybeans,

there being no intercropped plants other than said at least two commercial crops comprising corn and soybeans,

said corn and said soybeans planted in alternating patterns comprising corn rows and soybean areas respectively, each said soybean area and said corn row comprising a predetermined lateral width,

said annual green manure crop selected from the group consisting of buckwheat or buckwheat and wheat.

~~The improved intercropping and mulching method as describe din Claim 1, wherein said legume commercial crop is from the group consisting of~~ Austrian peas, hairy vetch, ~~red clover,~~ soybeans, annual rye grass and winter rye~~, and said annual green manure crop comprises buckwheat and wheat~~.

(Amended) Claim 10. The improved intercropping and mulching method as described in Claim 9[[7]], wherein said annual green manure crops are mowed with a conventional mechanical forage harvester.

(Amended) Claim 11.

The improved intercropping and mulching method as described in Claim [[1]] 10, wherein said combination green manure is sprayed upon said soil of said predetermined area after blending and chopping of said green manure plants and organic debris within a ~~conventional~~ bale chopper.

(Amended) Claim 12. The improved intercropping and mulching method as described in Claim [[6]] 11

wherein said intercropped soybeans are planted simultaneously with said intercropped corn by using a fork lift attachment with two forks, front end loader and tractor, ~~conventional~~ corn planter~~,~~ and a modified ~~conventional~~ seed drill, said modified seed drill and said fork lift ~~attachment~~ attaching to said tractor by said front end loader, said [[for]] fork lift attachment elevated with a hydraulic lift and a retrofit adapter.

(Amended) Claim 13. The improved intercropping and mulching method as described in Claim 12 wherein said ~~conventional~~ corn planter deposits said corn seeds between previously planted said soybean areas, said soybean areas consisting of soybean subrows, said soybean subrows deposited by said modified seed drill attached to said ~~prior-art~~ tractor, said corn seeds deposited within straight corn furrows.

(Amended) Claim 14. An improved intercropping and mulching method for corn and soybeans~~, said method~~ comprising:

(A) planting a commercial legume crop in the soil of a predetermined area during the summer, said commercial legume crop forming organic debris within said soil after harvesting of said commercial legume crop,

(B) no-till planting buckwheat and wheat during the following fall in said soil of said predetermined area, said buckwheat and said wheat growing until the following spring, said buckwheat and said wheat covering said soil during the winter,

(B) mowing ~~and tilling~~ said buckwheat and said wheat ~~within said soil~~ during said following spring, said mowing ~~and blending~~ accomplished by ~~using~~ a ~~conventional~~ forage harvester ~~and a conventional tilling machine~~,

a ~~first~~ second portion of said buckwheat and wheat forming [[a]] an annual green manure for said soil of said predetermined area, said organic debris also comprising said second portion,

a first ~~second~~ portion of said buckwheat and said wheat forming a combination mulch for said soil, said combination mulch further comprising said organic debris ~~after intercropping of said commercial crops~~,

(D) ~~creation of~~ creating consecutive corn rows, each said corn row comprising three subrows of soybean seeds within a soybean area, each said corn row further comprising one corn furrow, ~~and~~

(E) seeding said ~~soybeans~~ soybean seeds in alternating said soybean areas ~~between~~ within said consecutive corn rows by using a modified ~~conventional~~ seed drill[[,]] and a fork lift ~~and~~ with a front end loader[[;]] and a tractor,

said modified ~~conventional~~ seed drill comprising sets of three tru-vee openers along a horizontal opener draw bar ~~and a third frame, said tru-vee openers comprising seed tubes, each said true vee opener further comprising an opener spring,~~ said fork lift rigidly attached to said modified seed drill by a first fork and second fork, said forks attaching to said modified seed drill by enclosing one set of said tru-vee openers, said modified seed drill [[so]] aligned with said tractor so [[that]] said soybean seeds [[are]] ~~deposited~~ deposit directly beneath and anterior to the tractor center,

[[E]] (F) seeding said corn seed with a ~~conventional~~ corn planter attached posterior to said tractor, said corn planter creating said corn furrows within said soil ~~for planting of~~ corn, said corn furrows containing linearly deposited said corn seeds, said corn furrows

spaced laterally from each other approximately 30 inches, said soybean subrows located approximately midway between two consecutive said corn furrows,

[[(F)]] (G) covering said seeded soil with said combination mulch, ~~said conventional bale chopper chopping said green manure plants and organic debris to create said combination mulch,~~ said first portion of said green manure plants and organic debris placed within a forage box wagon ~~spun into unload augers~~ prior to chopping within said bale chopper to form said combination mulch, said combination mulch sprayed onto said soil of said predetermined area with a hose attached to a ~~conventional~~ bale chopper mounted to [[a] said forage box wagon.

(New) Claim 15. The method described in Claim 14 wherein said soybean seeds are planted at approximately eight to twenty seeds per square foot of said soil and said corn seeds are planted at approximately one corn seed per eight linear inches of said soil, said soybean seeds planted during the same pass across said preselected soil as said corn seeds.

(New) Claim 16. The method described in Claim 14 wherein said modified seed drill comprises eight said sets of said tru-vee openers and one center bar, a single said set of said tru-vee openers fitting between said first and second forks, said single set of tru-vee openers positioned immediately proximal to either side of said center bar, each said first and second fork resting upon said opener draw bar on either side of said single said set of said tru-vee openers, each said first and second fork attached to said opener draw bar by a clamp.

(New) Claim 17. The method described in Claim 14 wherein each said three soybean subrows comprising a soybean area is approximately 21 inches in lateral width.

(New) Claim 18. The method as described in Claim 14 wherein rotating augers pull said organic debris and said green manure plants from said forage wagon into said bale chopper, said bale chopper attaching to a discharge opening by sliding said bale chopper until interior surfaces of a bale tube fit snugly over exterior surfaces of panels of said storage box wagon.

(New) Claim 19. The method as described in Claim 14 wherein said true-vee openers are arranged in said sets of three, thereby leaving lateral space between each said set along said horizontal bar, each said set seeding soybeans within said three said soybean subrows when said modified seed drill is pulled by said tractor, each said lateral space seeded with said corn seed within said corn furrows while said corn planter is pulled by said tractor, said seeding of said corn seed and said soybean seed occurring with said modified seed drill and said corn planter operatively attached to a single tractor.

(New) Claim 20. The method as described in Claim 19 wherein
said two sides of a bale tube attach to said bale chopper, said two sides of said bale tube snugly fitting over an anterior and posterior panel, said anterior and posterior panels surrounding augers of said forage box wagon, said sides of said bale tube mechanically attached to said anterior and posterior panels, said forage box wagon physically attaching

to said bale chopper main frame with L-brackets, said green manure plants and organic debris chopped within said bale chopper main frame after passing said augers.

BRIEF

I. Current legal criteria for obviousness

(1) Suggestion or teaching to combine prior art

There are three possible sources for a motivation to combine references to establish a legal conclusion of obviousness: (i) the nature of the problem to be solved; (ii) the teachings of the prior art; and (iii) the knowledge of persons of ordinary skill in the art. **Manual of Patent Examination Procedure** 2143.01 (Eighth Ed. Rev.2 May 2004) [hereinafter MPEP].

The fact that one skilled in the art could modify prior art in a manner alleged by the government does not make such modification obvious. Instead, prior art must suggest the desirability of a particular modification. In re Fritch, 972 F.2d 1260, 1266, 23 U.S.P.Q.2d 1780, 1783-84 (Fed. Cir.1992) (flexible landscape edging device not suggested by hindsight combination of prior art). The prior art must also suggest the reasonable success of a particular modification. MPEP 2143.02.

(2) The claimed invention as a whole must be obvious

When determining differences between prior art and the applicant's claims, the correct inquiry is whether the claimed invention *as a whole* would have been obvious. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1537, 218 U.S.P.Q. 871, 877 (Fed. Cir. 1983) (emphasis added).

(3) The prior art cannot teach away from the claimed invention

A *prima facie* case of obviousness is rebutted by prior art which, in any material respect, teaches away from the claimed invention. MPEP 2141.02. A claimed combination cannot change the principle of operation of the primary prior art reference or render the reference inoperable for its intended purpose. *See* In re Ratti, 270 F.2d 810, 813, 123 U.S.P.Q. 349, 351-52 (C.C.P.A. 1959)(references taught rigid devices whereas the claimed invention required resiliency). A reference which teaches away from the claimed invention does not teach a combination of references which suggest that invention. *See* In re Fine, 837 F.2d 1071, 1074, 5 U.S.P.Q.2d 1596, 1599 (Fed. Cir. 1988).

(4) All claim limitations are considered

All claim limitations must be suggested by the government's prior art. MPEP section 2143.03. When evaluating a claim for obviousness, the government must consider all claim language. In re Wilson, 424 F.2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). If an independent claim is non-obvious, then any claims depending therefrom are non-obvious. In re Fine, 837 F.2d at 1076. Additional features of a claim are not obvious if they provide additional advantages to consumers. Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d 1569, 1581, 19 U.S.P.Q.2d 1241, 1250 (Fed. Cir. 1991) (second patent's claims recited additional features which achieve further advantages).

(5) Undue experimentation

An invention is not obvious where the prior art gives no direction as to which of many possible experimental choices may be successful. *See* Boehninger Ingelheim Vetmedica,

Inc. v. Schering–Plough Corp., 166 F. Supp.2d 19, 37 (D.N.J.2001), *affirmed* 320 F.3d 1339, 1354 65 U.S.P.Q.2d 1961, 1971 (Fed. Cir. 2003).

(6) Inherency

An inherent property is a necessary feature or result of a prior art embodiment (which is itself sufficiently described). MPEP 2112 II. Inherency is not established by probabilities or possibilities. MPEP 2112 IV. The government must reasonably support a determination that an allegedly inherent characteristic necessarily results from prior art teachings. MPEP 2112 IV.

Non-obviousness may depend upon unexpected advantages from inherent properties which an invention enhances. In re Adams, 356 F.2d 998, 1002-03, 148 U.S.P.Q. 742, 745-46 (C.C.P.A.1966) (prior art did not suggest the unexpected increase in heat transfer *efficiency* of aqueous foam in applicant's device, although the industry knew that this foam *per se* transfers heat) (emphasis added). In these cases the advantageous inherent physical property is maximized by the invention's design, structure or function. *Id.* (the new device producing aqueous foam was designed to reduce splashing and increase contact of aqueous foam with a rounded container surface).

Even if a change appears small, the invention which contains the change is non–obvious if the change provides previously unknown practical uses. *See* Intel Corp. v. U.S. Int'l Trade Commission, 946 F.2d 821, 20 U.S.P.Q.2d 1161, 1173 (Fed.Cir.1991). Disclosed inherent properties are also part of the "as a whole" inquiry. MPEP 2141.02. Parameters

which successfully optimize an inherent property are non-obvious if the prior art did not recognize these parameters as result-effective variables. *Id.*

(7) Official Notice

The government must support technical assertions of official notice with technical evidence. MPEP 2144.03. Official notice is inappropriate without a prior art reference whenever the asserted facts are not capable of instant and unquestionable demonstration. MPEP 2144.03A. The government's assertion of technical facts must be supported by a reference work which is recognized as a standard in the pertinent art. MPEP 2144.03A.

II. The Government's Prior Art References

Applicant has reviewed the complete original research articles on which the government's abstracts are based:

1. Yao-Chi Lu et al, "Economic Analysis of Sustainable Agricultural Cropping Systems for Mid-Atlantic States," **Journal of Sustainable Agriculture** 15(2-3): 77-93 (1999)[hereinafter " Lu"]. This study evaluates the profitability of: (1) no tillage systems with chemical fertilizers and herbicides; (2) no tillage systems with crown vetch living mulch; (3) no-tillage systems with a winter annual cover crop; and (4) a reduced tillage manure based system without chemical fertilizers but containing green manure. Lu, pages 81-82.

The experimental design comprised a randomized complete block with four smaller blocks. Each block contained four cropping systems assigned permanently to two plots. Plot pairs alternated between the corn and wheat/soybean phases of rotation, so two

phases of rotation occurred annually for each cropping system. *Id.*, page 80, third paragraph.

The crown vetch system followed similar guidelines for the conventional no tillage system presently in widespread use, except crops grow within a perennial crown vetch living mulch. *Id.,* page 81, third paragraph.

The crop covers system applied winter annual species hairy vetch prior to corn and wheat before soybean. Because there was insufficient time to plant hairy vetch following a wheat/soybean double crop, a full season soybean crop was grown between May and September to permit time to plant hairy vetch in October. Crops were planted into cover crops without tillage. Pre-emergence herbicides were eliminated and only post-emergence herbicides were used as needed. Only planter and side dress nitrogen were applied. *Id,* page 81, fourth paragraph.

2. T.K. Iragavarapu et al., "Border Effects on Yields in a strip-intercropped soybean, corn and wheat production system," **Journal of Production Agriculture** 9(1): 101-107(1996)[hereinafter "Iragavarapu"]

This study compared grain yield of soybeans and corn in a three –crop system, to that of a two crop corn–soybean system. Iragavrapu, page 102, second paragraph. The goal of the study was to determine optimization of yields in three crop intercropped strip models, in lieu of two crop intercropped strip models or the classic monocrop model. Field experiments were conducted from 1991 through 1994 at two sites in southern Minnesota.

Rows were oriented east/west at one site and north-south at the second, and the soil type was poorly drained. Soybeans were grown on ridges in all strips at both sites in 1990. *Id.*, third paragraph.

Iragavarapu planted wheat, corn and soybeans as strip intercrops on these ridges. Each crop was planted in a 15-ft wide by 120 foot long strip, with six rows each of corn and soybeans and 21 rows of wheat per strip. Crops were rotated each year so corn followed wheat, soybean followed corn and wheat followed soybean. Corn and soybean were also planted and rotated in a two-crop alternate strip system within each replication at both locations. *Id.* fourth paragraph.

Corn "pioneer hybrid 3751" and soy bean "Sturdy" were planted on the same day in 30 inch rows with a six row planter on ridges which were scalped to remove one to two inches of soil and previous crop residue. Soybean was planted at 9 to 10 seeds/foot of row. Spring wheat "Grandin" was planted at 94 pounds per acre directly into the soybean stubble without secondary tillage and using a no till drill following an application of 50 pounds N/acre as ammonium nitrate.

Alachlor and cyanazine were applied as pre-emergence herbicides for corn. For soybeans, alachlor was applied at pre-emergence, and imazethapyr was applied at the first trifoliate stage. Bromoxynil was broadcast to wheat before flagleaf stage to control broadleaf weeds. *Id,* page 103, first paragraph, last sentence.

III. Amended Claims 1-7 and 10 are not obvious based upon Iragavarapu et al. in view of Lu et al.

Amended Claim 1

There are no suggestions in Iragavarapu in view of Lu for the amended claim 1 method. According to the government Iragavarapu discloses a method for intercropping corn and soybeans. March 22, 2005 Office Action, page 5, first paragraph. It also contends that Lu discloses an 'annual green manure crop,' and the government assumes that this term is the agricultural and horticultural equivalent of a 'winter annual cover crop.' *Id.* The government has no technical support for these assumptions, and Applicant cannot identify the term "winter annual cover crop" within Lu. MPEP 2144.03. Furthermore, claim meaning is defined by the specification. MPEP 2111.01. Applicant's specification defines an annual green manure crop, but not a winter annual cover crop.

The government also contends that it is obvious to plant green manure in two portions and similarly to Lu, Applicant's green manure is harvested prior to seeding of the commercial spring-planted crop. March 22, 2005 Office Action, page 5, first paragraph. However, Lu planted his commercial crops within perennial viable crown vetch. Lu, page 81, third paragraph. In fact, Lu's perennial crown vetch is planted after a wheat harvest and remains viable during a two year period. Under these circumstances, the perennial crown vetch is not necessarily harvested prior to seeding of the commercial crop, and in fact may not be harvested at any time. *Id.*

Furthermore, amended Claim 1 recites combined green manure and combination mulch which is applied to pre-selected soil at (1) different depths and (2) different dates during

the growing season. Lu discloses a cover crop system with hairy vetch planting during October, but neither first nor second portions containing mowed hairy vetch or any other cover crop are disclosed or suggested. *Id.* page 81, third paragraph. There are also no subsequent dates for addition of hairy vetch or crown vetch as a combination mulch.

Lu's manure/crimson clover system also does not disclose growth and application of (1) two portions of any plant for soil treatment (2) at two different dates during the growing season. *Id.*, page 82, first paragraph. Lu's no tillage system does contain a green manure planting or green manure in any form, *id.*, second paragraph, and his manure-based system contains crimson clover to overseed into soybeans. Neither the clover nor soybeans are divided into portions or allocations in Lu's disclosure. Lu, page 82,first paragraph. Based upon Lu, a third party skilled in the art would not be inclined to diverge from the practice of growing green manure plants and applying them to the soil at one date and at one soil level.

The government has not specified the exact passage of Lu which suggests that first and second portions are leaves and stems, respectively. According to Lu's full text article, hairy vetch, crown vetch and crimson clover become ground covers in their entirety, and not as a first combined mulch portion or a second combined green manure portion. *See* In re Fritch, 972 F.2d at 1266 (flexible landscape edging device not suggested by hindsight combination of prior art); MPEP 2143.02 (the prior art must suggest the reasonable success of a particular modification).

In addition, Applicant's specification defines a first or second portion of combined green manure as follows:

Application, paragraph 21 ("green manure *plants*"),

Application, paragraph 65 (harvesting a *portion* of the green manure *plants* 44a for mulch 20; quick tilling a *portion* of green manure *plants* 44a and organic debris 19 into the soil 45).

Application, paragraph 66 (The farmer next mows green manure *plants* 44a and plant debris 19, which becomes combination mulch 20....")

Application, paragraph 78 ("The approximately one-half of wheat grass 18a is chopped and blended with organic debris 19 to become combined mulch 20.... The remaining approximately one–half of the bottom portions of.... (such as wheat grass 18a) is tilled into soil 45 with organic debris 19....")

Based upon this express language, the first and second portions of original and amended Claim 1 are not exclusively leaves and stems respectively as the government contends. MPEP 2111.01 I, III.

Amended Claim 1 also recites (1) the components of the organic residue, (2) annual green manure plants which remain unmowed until tillage; and (3) application of combined green manure approximately nine to fourteen inches into said soil. Application, paragraphs 6, 26 and 66. The government must specify which passages from the full text of Lu and Iragavarapu suggest these features.

Furthermore, Iragavarapu's goals are (1) maximizing grain yields with wheat between corn and soybean and soybean strips; and (2) grain yield of soybean and corn in three

crop systems, compared to exclusively two crop corn-soybean systems. Lu's goal is assessment of profitability of different cropping systems with minimum tillage. Based upon these two references, one skilled in the art would not be expected to combine (1) a system with no green manure/mulch system, with (2) a system which relies upon minimum tillage systems with or without a green manure or mulch. *See* In re Fine, 837 F.2d at 1076 (purposes of two temperature ranges are entirely unrelated, so prior art did not teach use of claimed range).

Amended Claim 1 as a whole must be obvious

The government has not addressed the features of amended claim 1 such as: mowing of green manure plants immediately prior to tillage; use of a single portion of the green manure plants and organic debris as combined mulch; the composition of the organic debris; and spraying of combined mulch upon the soil surface after seeding commercial crops. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537. Lu and Iragavarapu do not suggest spraying mulch at a specific depth, after tilling viable combined green mulch which contains intact soybean roots and nodules, when the invention is considered as a whole.

The prior art teaches away from the claimed invention

Iragavarapu teaches away from amended Claim 1 because he applies ammonium nitrate, cyanazine, alachlor, bromoxynil and imzaethapyr to commercial crops of corn and soybeans. Similarly Lu teaches away from amended Claim 1 because his (1) no-tillage method does not include any form of green manure; (2) no-tillage method includes

artificial fertilizer; and (3) no-tillage, crown vetch and cover crop systems include herbicides. Lu, page 81, second, third and fourth paragraphs.

In contrast, amended Claim 1 expressly excludes artificial fertilizer, pesticides and herbicides. Application, paragraph 4; MPEP 2141.02; *see also* In re Ratti, 270 F.2d at 813 (references taught rigid devices whereas the claimed invention required resiliency; In re Fine, 837 F.2d at 1074 (a reference which teaches away from the claimed invention cannot be combined to suggest the invention).

The government did not consider all claim limitations and language

The government has not considered all the limitations of amended Claim 1 which include: the specific depth of combined green manure in the soil; absence of fertilizers, both biological and artificial; and two portions of combined green manure plants and organic residue which are applied at different stages and at different soil levels for seeding of commercial crops. In re Wilson, 424 F.2d at 1385 (all claim language must be considered).

Furthermore, a modification such as the absence of fertilizers, pesticides and herbicides, is tremendous advantage, because the cost for raising commercial crops is significantly lower. There are also are short-term and long–term ecological benefits which result in less accumulation of chemicals within soil, water and crops. *See* Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d at 1581 (second patent's claims recited additional features which achieve further advantages). Even if the changes appeared deceptively small, amended Claim 1 features such as composition of organic debris, as well as timing and

depth of combined mulch and combined green manure within the soil, provide previously unknown practical uses (such as more productive growing seasons without fertilizer and herbicide costs). *See* Intel Corp. v. U.S. Int'l Trade Commission, 20 U.S.P.Q.2d at 1173.

Inherency

Amended Claim 1 features which do not inevitably result from Iragavarapu in view of Lu include:

(a) an organic residue containing desiccated intact soybean roots and nitrogen nodules;

(b) a first portion and a second portion of combined green manure plants and organic residue which are applied to the soil at different depths and at different stages of seeding the commercial crops;

(c) an annual green manure crop containing green manure plants which remain unmowed until tillage and seeding of commercial crops;

(d) absence of artificial pesticides, herbicides or fertilizer; and

(e) absence of manure.

Since inherency is not mere possibility, MPEP 2112 IV., features such as desiccated intact soybean roots and nitrogen nodules do not necessarily result from the general features of intercropping, strip cropping, or use of a green manure within the government's references. MPEP 2112 II.

Furthermore, although the benefits of mulch and green manure are known, no one could predict increased soil productivity at lower cost, from the amended Claim 1 method which enhances the benefits of green manure plants and organic residue as both a

combined green manure and a combined mulch. *See* In re Adams, 356 F.2d at 1002-03 (prior art did not suggest the unexpected increase in heat transfer *efficiency* of aqueous foam in applicant's device, although those in the art knew that this foam *per se* transfers heat) (emphasis added).

Undue experimentation

Iragavarapu in view of Lu does not suggest parameters such as combined mulch composition, combined green manure composition, fertilizer, herbicides, and timing of tillage. *See* Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354 (an invention is not obvious where the prior art gives no direction to the successful experimental parameters).

Official Notice

The government has not provided technical evidence to support its statement that its references suggest an annual green manure crop in two portions combined with intact organic residue. MPEP 2144.03; MPEP 2144.03A. In fact there are potential methods in which green manure plants are not combined with organic residue, or in which the organic residue in the soil differs from the composition of amended Claim 1.

Amended Claim 2

Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claim 1 herein. If independent amended Claim 1 is non–obvious then amended Claim 2 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076. In addition, an intercropped legume is only one element of amended Claim 2. The government must

address amended Claim 2 as a whole and all amended Claim 2 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537; In re Wilson, 424 F.2d at 1385.

For obviousness, Iragavarpu and Lu must suggest the combined method of amended Claim 1 and not merely disclose intercropped legumes. *See* In re Fritch, 972 F.2d at 1266; MPEP 2143.02; Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d 1065, 1075 (Fed. Cir. 2000) (a reference by reference, limitation by limitation analysis does not demonstrate how prior art teaches the claimed combination).

Amended Claim 3

Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claim 1 herein. If independent amended Claim 1 is non–obvious, then amended Claim 3 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

In addition, intercropped soybeans are only one element of amended Claim 3. The government must address amended Claim 3 as a whole and all amended Claim 3 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537; In re Wilson, 424 F.2d at 1385. Iragavarpu and Lu must also suggest the combined method of amended Claim 3 and not merely intercropped soybeans which are present in other contexts in prior art. *See* In re Fritch, 972 F.2d at 1266; MPEP 2143.02; Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d at 1075 (reference by reference, limitation by limitation analysis does not demonstrate how prior art teaches the claimed combination).

The government must also explain exactly how amended Claim 3 inevitably results from its prior art, and how amended Claim 3 is created by those skilled in the art without undue experimentation. *See* In re Adams, 356 F.2d at 1002-03; Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354.

Amended Claim 4

Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claim 1 herein. If independent amended Claim 1 is non–obvious then amended Claim 4 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

In addition, intercropped corn is only one element of amended Claim 4. The government must address amended Claim 4 as a whole and all amended Claim 4 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537; In re Wilson, 424 F.2d at 1385. Iragavarpu and Lu must suggest the combined features of amended Claim 4 and not merely intercropped corn which is an isolated element in another context in the prior art. *See* In re Fritch, 972 F.2d at 1266; MPEP 2143.02; Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d at 1075.

The government must also explain exactly how amended Claim 4 inevitably results from its prior art, and how amended Claim 4 is created by those skilled in the art without undue experimentation. *See* In re Adams, 356 F.2d at 1002-03; Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354.

Amended Claim 5

Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claim 1 herein. If independent amended Claim 1 is non–obvious, then amended Claim 5 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

Furthermore, intercropped soybeans and corn are only two elements of amended Claim 5. The government must address amended Claim 5 as a whole and all amended Claim 5 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537; In re Wilson, 424 F.2d at 1385. Iragavarpu and Lu must also suggest the combined features of amended Claim 5 and not merely intercropped soybeans and corn in other contexts from prior art. *See* In re Fritch, 972 F.2d at 1266; MPEP 2143.02; Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d at 1075.

The government must also explain exactly how amended Claim 5 inevitably results from its prior art, and how amended Claim 5 is created by those skilled in the art without undue experimentation. *See* In re Adams, 356 F.2d at 1002-03; Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354.

Amended Claim 6

Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claim 1 herein. If independent amended Claim 1 is non–obvious then amended Claim 6 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

Furthermore, intercropped soybeans and corn are only two elements of amended Claim 6. The government must address amended Claim 6 as a whole, as well as all the amended Claim 6 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 15, 37; In re Wilson, 424 F.2d at 1385. Iragavarpu and Lu must also suggest the combined features of amended Claim 6 and not merely exclusively intercropped soybeans and corn as an isolated element in other contexts from prior art. *See* In re Fritch, 972 F.2d at 1266; MPEP 2143.02; Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d at 1075.

The government must also explain exactly how amended Claim 6 inevitably results from its prior art, and how amended Claim 6 is created by those skilled in the art without undue experimentation. *See* In re Adams, 356 F.2d at 1002-03; Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354.

Amended Claim 7

Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claims 1 and 6 herein. If independent amended Claim 1 is non–obvious then amended Claim 7 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

Furthermore, an alternating pattern for soybeans and corn is only one element of amended Claim 7. The government must address amended Claim 7 as a whole and all amended Claim 7 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537; In re Wilson, 424 F.2d at 1385. Iragavarpu and Lu must suggest the combined features of amended Claim 7 and not merely the isolated element of alternating seeded soybeans and

corn from other contexts in prior art. *See* In re Fritch, 972 F.2d at 1266; MPEP 2143.02; Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d at 1075.

The government must also explain exactly how amended Claim 7 inevitably results from its prior art, and how amended Claim 7 is created by those skilled in the art without undue experimentation. *See* In re Adams, 356 F.2d at 1002-03; Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354.

Amended Claim 8

The government did not specifically address its Claim 8 rejection in its first office action. However, Applicant incorporates his entire analysis *supra* for the non–obviousness of amended Claims 1 herein. If independent amended Claim 1 is non–obvious, then amended Claim 8 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

Furthermore, buckwheat as a green manure crop is only one element of amended Claim 8. The government must address amended Claim 8 as a whole, as well as all amended Claim 8 language. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537; In re Wilson, 424 F.2d at 1385. Iragavarpu and Lu must suggest the combined features of amended Claim 8 and not merely buckwheat in other prior art contexts. Ecolochem, Inc. v. Southern California Edison Co., 56 U.S.P.Q.2d at 1075.

The government must also explain exactly how amended Claim 8 inevitably results from its prior art, and how amended Claim 8 is created by those skilled in the art without

undue experimentation. *See* In re Adams, 356 F.2d at 1002-03; Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354.

Amended Claim 10

Applicant has amended Claim 9 to include all the limitations of original Claim 1 and the original intervening claims. He has also modified the claim language pursuant to the government's requests under section 112, second paragraph. March 22, 2005 Office Action, page 6, Allowable Subject Matter. Claim 9 is now allowable and amended Claim 10 depends from Claim 9. If independent amended Claim 9 is non-obvious, then amended Claim 10 depending therefrom is also non-obvious. In re Fine, 837 F.2d at 1076.

Amended Claims 11-13

Claims 11-13 are now amended to include all the limitations of amended Claim 1 and intervening claims pursuant to the government's requests. March 22, 2005 Office Action, page 6, Allowable Subject Matter. In addition amended Claim 9 is now allowable and amended Claims 11-13 depend from Claim 9. If independent amended Claim 9 is non–obvious then amended Claims 11-13 depending therefrom are also non-obvious. In re Fine, 837 F.2d at 1076.

Amended Claim 14

The government did not address original Claim 14 in its office action, but amended Claim 14 is non-obvious for the following reasons:

The government's prior art does not suggest the amended Claim 14 invention.

Amended Claim 14 includes the following features:

(1) planting of a commercial legume crop during the summer to form organic debris within preselected soil,

(2) no-till planting of buckwheat and wheat over the same soil during the following fall;

(3) mowing of the buckwheat and wheat in the spring,

(4) tilling a second portion of buckwheat and wheat with organic debris into the same soil,

(5) producing combination mulch with the first portion of buckwheat, wheat and organic debris by using a bale chopper,

(6) creating consecutive corn rows, each of which are seeded with corn within furrows and which corn rows also contain three subrows of soybean seeds,

(7) use of a modified seed drill and forklift attached to the seed drill, as well as a corn planter which produces corn furrows at lateral intervals of thirty inches.

Iragavarapu does not suggest these features, because he planted three crops-- wheat, corn and soybeans-- simultaneously upon ridges as commercial crops. Iragavarapu, page 103, Materials and Methods, second paragraph.

In contrast, the amended Claim 14 method requires (1) planting of only corn and soybeans as the commercial crops, (2) planting a preliminary legume crop planted almost one growing season prior to seeding of corn and soybeans as commercial crops, and (3)

planting wheat and buckwheat the following fall as green manure plants, and not simultaneously with corn and soybeans as a commercial crop. Application, paragraphs 72, 74, 78, 80, 84, 93 and 92-97. There is no disclosure of a modified bale chopper or other modified machinery of any kind for the amended Claim 14 method in Iragavarapu. Application, paragraphs 123, 129, 134 and 139.

Without the goal of modifying machinery for efficient use of the farmer's time and current investment, Iragavarapu has no suggestion for the reasonable success and desirability of modifying farm tools to enhance productivity. MPEP 2143.02. Furthermore, Ivaragrapu uses ridges, and not furrows and soybean areas, for the commercial crops.

Lu's four cropping systems, alone or in combination with Iragavarapu, do not suggest amended Claim 14 because:

(1) His non-tillage system does not apply tillage in any manner and does not use mulch or green manure in any form or combination, In re Fritch, 972 F.2d at 1266;

(2) The crownvetch system does not apply tillage in any manner and there is no green manure of any form. Moreover, unlike Applicant's buckwheat and wheat Lu's crownvetch remains perennial living mulch which is never mowed. Instead, Lu's commercial crops are seeded into the viable crownvetch which remains viable throughout the growth of the commercial crops. Lu, page 81, third paragraph.

(3) The cover crop system uses hairy vetch as a cover crop and nitrogen source for corn, but the corn and soybeans are planted into the hairy vetch without tillage;

(4) The manure-based system uses crimson clover as an additional green manure to animal manure. However, no tillage is disclosed for this the method, and there is no disclosure of clover divided into portions for green manure or mulch. *Id.* page 82, first paragraph. *See* MPEP 2143.02(the prior art must suggest the reasonable success of a modification).

Iragavarapu in view of Lu does not suggest amended Claim 14 as a whole

Iragavarapu discloses a method in which wheat, corn and soybeans are seeded simultaneously in strips along ridges "with six rows each of corn and soybean and 21 rows of wheat per strip." Iragavarapu, page 102, Materials and Methods, second paragraph; Figure 1. This pattern does not suggest amended Claim 14 as a whole, because these features of Iragavarapu are merely isolated elements. Furthermore, these strips are not designed so a modified seed drill and a corn planter deposit soybean seeds and corn seed within a single pass. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d at 1537.

Iragavarapu in view of Lu does not suggest all amended Claim 14 limitations

Neither Iragavarapu nor Lu disclose any modified machinery for growing, seeding, mowing and blending the plant combinations of amended Claim 14. Lu discloses cropping methods which include mulch and green manure. However, these features are isolated elements which must be combined and reviewed with the remaining language of amended Claim 14. For example, the government must address the modified machinery for seeding corn and soybeans, as well as the modified machinery for producing combined mulch. Furthermore, Lu's viable crownvetch and clover/manure systems do

not suggest the desirability of mowing and chopping the green manure plants with organic debris. In re Wilson, 424 F.2d at 1385.

Iragavarapu in view of Lu teaches away from amended Claim 14

Amended Claim 14 recites planting of wheat and buckwheat as green manure plants, while Iragavarapu discloses wheat planted simultaneously with corn and soybean, and not as a green manure plant. Lu's first cropping system does not include a mulch, and his second and third systems require mulches which are not quick-tilled into the soil prior to planting of corn and soybeans. Although his fourth system includes crimson clover as a green manure, it supplements animal manure. There is also is no disclosure of the time of seeding of the clover or its subsequent collection from the field.

Significantly, neither Lu nor Iragavarpu teach an initial legume crop which is planted earlier than the annual green manure plants within the same predetermined soil. This lack of the initial step of amended Claim 14 is clear evidence of teaching away, because one skilled in the art would not be prompted to (for example) (1) plant a legume which is left intact prior to planting of the green manure crop in the fall; or (2) quick-till mowed wheat and buckwheat into the soil prior to seeding of corn and soybeans in consecutive lateral patterns, based upon the government's prior art. MPEP 2141.02; In re Ratti, 270 F.2d at 813 (references taught rigid devices whereas the claimed invention required resiliency); *see also* In re Fine, 837 F.2d at 1074.

Furthermore, the government's references do not suggest combining and modifying machinery to more efficiently intercrop two commercial crops in terms of cost and time.

See Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d at 1581 (second patent's claims recited additional features which achieve further advantages); see also Intel Corp. v. U.S. Int'l Trade Commission, 20 U.S.P.Q.2d at 1173.

Undue Experimentation

Iragavarapu in view of Lu contains no passages with possible parameters for successfully modifying particular machinery, timing of planting legumes, or when or how to allocate particular plants and organic debris for green manure and mulch to obtain amended Claim 14. *See* Boehninger Ingelheim Vetmedica, Inc. v. Schering–Plough Corp., 166 F. Supp.2d at 37, 320 F.3d at 1354 (an invention is not obvious where the prior art gives no direction to the successful experimental parameters).

Iragavarapu in view of Lu does not teach inherency of amended Claim 14

Mulch and green manure are well recognized as beneficial for growing crops such as soybeans and corn. Ghaffarzadeh et al, "Economic and biological benefits of intercropping bereem clover," **Journal of Production Agriculture**, 10:314-319, 315, col.1, third paragraph (1997). However, it is the specific manner in which amended Claim 14 applies mulch and green manure, and how they are produced and combined with other materials, which results in improved soil. It is also well known that planting commercial crops in strips is beneficial to the soil. However, it is the specific manner in which Applicant has combined corn furrows and subrows of soybeans which contributes to simultaneously seeding of corn and soybeans in one pass.

Similarly the manner in which the machinery is used, as well as structural modifications and combination with other machinery, results in a more efficient method to seed intercropped corn and soybeans. *See* In re Adams, 356 F.2d at 1002-03. The specific manner in which combination mulch flows directly from a forage box wagon, reduces the time and labor required to move green manure plants from the wagon to the bale chopper. *See id.*

These maximizing features of amended Claim 14 do not inevitably result from prior art embodiments such as Iragavarapu in view of Lu. MPEP 2112 II.

MPEP 2141.02 (parameters which are successfully optimized to enhance an inherent property are non-obvious if the prior art did not recognize these parameters as result-effective variables). In this case, the result-effective variables included: modification of machinery, new combinations of machinery; the planting of a summer legume left intact for growth of a green manure plant; selection of the optimal green manure plant for this particular crop system; lateral spacing of corn and soybean crops, and ingredients of a combination mulch, to name just a few.

IV. Prior Art of Record

(1) U.S. Pat. NO. US 6,631,585 (Marvin J. Williams, Jr.) discloses an intercropping system for corn and soybeans. However Williams, Jr. does not disclose modified machinery for spring seeding corn and soybeans simultaneously; combination mulch, annual combination green manure, or selection and growth conditions for annual green

manure plants. Williams, Jr. also does not disclose the summer planting of a legume which remains intact in the soil to nourish a subsequent green manure crop.

(2) Ghaffarzadeh, "Economic and biological benefits of intercropping berseem clover with oat in corn-soybean-oat rotations." **Journal of Production Agriculture** 10:314-319 (1997) [hereinafter Ghaffarzadeh]. In Treatment I, Ghaffarzadeh seeded a mixture of oat and hairy vetch as a cover crop approximately one month after an oat harvest. However, hairy vetch re-growth was killed with glyphosate and seeding a cover crop was discontinued. No herbicide or fertilizer were applied to the oat crops.

For Treatment II Ghaffarzadeh seeded berseem clover with oats in the spring. For both treatments I and II, ammonium nitrate or urea were manually applied to corn subplots. Corn and soybeans were both cultivated, and in late August oat plots in Treatment I were tilled to control excessive weed growth. Pre-emergence weed growth was controlled by banding granular alachlor. Berseem clover was winter killed and was no management obstacle for corn the next spring. Berseem clover cover grew with oats and provided hay or remained as green manure. Also, for Treatment II intercropping berseem clover with oats resulted in greater economic return than sole-cropped oats. Regrowth berseem clover was left as a cover crop (green manure) to protect the soil and contribute nitrogen to the succeeding corn crop.

This study did not disclose or teach mowing and quick tilling of a green manure crop, as the clover was killed artificially during the winter to prevent regrowth. Consequently,

there is no suggestion of allocating clover portions for combination green manure and combination mulch. There is also no disclosure or suggestion of how to modify existing machinery to more efficiently seed intercropped corn and soybeans.

REMARKS

1.For 112 rejections of Claim 1: "Said first portion of said combined mulch" has antecedent basis in Clause (2) which reads at the end of that clause:

"said first portion of said combined green manure becoming a combination mulch",

2. The last two clauses of amended Claim 9 are modified to accurately reflect the selection of green manure plants, and not commercial legume plants. Application, paragraph 77.

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On behalf of

Marvin J. Williams, Jr.

Applicant and Inventor

Small Grains

Economic and Biological Benefits of Intercropping Berseem Clover with Oat in Corn-Soybean-Oat Rotations

Mohammadreza Ghaffarzadeh*

Sustainability of Iowa agriculture may require change from predominantly a corn (*Zea mays* L.)-soybean [*Glycine max* (L.) Merr.] rotation to more diverse cropping systems. Alternative crops are vital for providing temporal diversity. Reincorporating small grains into a three-crop rotation with corn and soybean can provide greater temporal diversity, especially if a forage legume is included as a companion crop. A field study was established in 1991 on a Kenyon (fine-loamy, mixed, mesic Typic Hapludoll) soil to evaluate the economic and biological benefits of an oat (*Avena sativa* L.) crop underseeded with berseem clover (*Trifolium alexandrinum* L.) in a three crop- rotation. Two rotation treatments were compared: (i) corn-soybean-oat and (ii) corn-soybean-oat intercropped with berseem clover. In 1992, 1993, 1994, and 1995, oat grain yield was not significantly changed when berseem clover was underseeded with the oat crop. However, in 5 yr, oat underseeded with berseem clover produced up to 70% more biomass (harvested material without the grain) than sole-crop oat straw. The biomass (40% oat straw and 60% berseem clover forage) also had adequate digestible material (51%) to be considered as low quality forage. Berseem clover regrowth after oat grain harvest produced an average 1.2 tons/acre of forage, which could have been harvested for hay or left in the field as green manure. During this trial, berseem clover regrowth was left as groundcover and green manure, which contributed an average of 39 lb N/acre to the succeeding corn crop. Corn grain yields following berseem clover were 10% higher over the trial period. Soybean grain yields were the same for both treatments. Intercropping berseem clover with oat returned an average of $39/acre more than sole-crop oat. This study demonstrated both economic and biological advantages for more diverse cropping practices.

INCREASED CORN AND SOYBEAN production throughout the Midwest has decreased crop diversity, contributed to significant environmental problems, and limited opportunities to integrate livestock into the cropping system. In Iowa, approximately 78% (12 million acres of corn and 9 million acres of soybean) of 27 million harvested acres are under corn and soybean production (Iowa Agricultural Statistics, 1992–1996). Approximately, 65% of corn acres are managed with a corn-soybean crop sequence, 30% with continuous corn, and the rest with other rotations. Research in Minnesota (Crookston et al., 1991) suggests that adding a third crop, and possibly more, between the corn-soybean sequence will create a superior cropping system, particularly from the corn and soybean yield standpoint. However, finding a grain crop that compares economically with corn and soybean is difficult. Small grains are a favorable candidate for a three-crop rotation. The inclusion of small grains in crop rotations in Iowa, however, has been unpopular, largely because of low grain market value and high variability in grain yield. Oat accounts for approximately 89% of all small grains grown in Iowa. More than 750 000 acres of oat are planted each year, but only 225 000 acres are harvested for grain (Iowa Agricultural Statistics, 1992–1996). The remaining acres are harvested as hay or silage, or to satisfy government program requirements.

The use of cover crops is increasing for several reasons. They reduce soil erosion (Ebelhar et al., 1984; Scott et al., 1987), increase water infiltration (McVay et al., 1989; Wilson et al., 1982), and improve soil productivity (Hargrove and Frye, 1987). The low percentage of groundcover with annual grain crops, particularly from soybean, results in soil exposure to water and wind erosion, increases potential for leaching of soil nitrate N, and reduces N availability for the subsequent crop. Small grains permit the inclusion of forage legumes as a cover crop in the crop rotation. In a no-till system, legume winter cover crops provided biologically fixed N equivalent to 58 to 120 lb/acre of fertilizer N to grain sorghum [*Sorghum bicolor* (L.) Moench] and other succeeding summer crops (Blevins et al., 1990). In the midwestern USA, oat easily accommodates inclusion of a forage legume as a companion crop or cover crop after grain harvest. Legume cover crops may contribute N to the subsequent crop (corn or grain sorghum) and reduce the fertilizer requirement by 65 lb N/acre or more (Hargrove, 1986; McVay et al., 1989; Holderbaum et al., 1990). In northern climates, approximately 90 lb N/acre can be contributed to the succeeding corn crop by underseeded or interseeded legumes (Bruulsema and Christie, 1987).

Conventional small grain-legume combinations in Iowa consist of oat underseeded with alfalfa (*Medicago sativa* L.) or mammoth red clover (*Trifolium pratense* L.). Rye (*Secale cereale* L.) or oat mixtures with hairy vetch (*Vicia villosa* Roth subsp. *villosa*) seeded after small-grain harvest is also a common practice. However, chemical or mechanical elimination of these cover crops in the fall or early in the spring before planting or germination of the succeeding crop is a major management consideration. Spring regrowth of bien-

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Abbreviation: NFRV, N fertilizer replacement value.

nial cover crops may deplete soil moisture to the extent that subsequent crop grain production is decreased (Ebelhar et al., 1984; Frye et al., 1988; Badaruddin and Meyer, 1989; Hesterman et al., 1992).

Selecting an appropriate legume cover crop requires consideration of the legume characteristics, its associations with the primary crop, management practices, and environmental factors. Berseem clover, commonly known as Egyptian clover, grows rapidly after seeding and, in contrast to traditional legumes, is a true annual that winter-kills in Iowa. Berseem clover also responds very well to multiple cutting schedules (Baldridge et al., 1992), has high forage quality, and has abundant biomass production (Brink and Fairbrother, 1992; Singh et al., 1989). Singh et al. (1989) found that the oat-berseem clover combination may produce 4.5 tons/acre of high quality biomass. Oat underseeded with berseem clover offers alternative harvesting options during the growing season. For example, in an anticipation of poor oat grain yield or quality, the producer may harvest the small grain-berseem combination as hay or silage. Grazing has also been investigated, and there have been no reported cases of bloat for ruminant animals (Baldridge et al., 1992; Sims et al., 1991).

The amount of legume N contributed under different environmental, cropping, and soil conditions is unclear. Most evaluations of legume N contributions have been conducted specifically with the legume as a green manure or within a rotation following the complete life cycle of the legume species. Companion legume crops are not often grown to maturity and are subject to competition from primary crops. In particular, the N_2 fixation of a companion legume crop may be very susceptible to shading within the intercropping conditions (Nambiar et al., 1983). Thus, N contributions by a companion legume-cover crop on an annual basis remains unknown.

Tillage practices also influence availability of the legume-contributed N to the succeeding crop (Heichel, 1987), especially since plowdown or incorporation of biomass does not occur in no-till and ridge-tillage systems. Studies in Nebraska showed that, in a no-till system, a hairy vetch cover crop increased soil nitrate, but not until 50 to 78 d after the succeeding corn crop was planted (Brown et al., 1993). This increase in soil nitrate occurred after corn silking, at which time more than 70% of the plant N need had already been met and additional mineralized N has little effect on yield (Hanway, 1963).

The benefits of legume cover crops grown in rotation have been widely demonstrated. Major limitations in determining the environmental importance and economics of intercropped legume cover crops remains because little reliable data exist for specific environments and crop rotation sequences. The objectives of this study were to evaluate the economic and biological benefits of an oat crop underseeded with berseem clover in a three-crop rotation.

MATERIALS AND METHODS

A field experiment was conducted for 5 yr (1991–1995) on Kenyon soil with a maximum 5% slope at the Northeast Iowa Research Farm near Nashua. The experimental design was a split-plot with two whole plots (three-crop rotation) randomized within four blocks. Whole plots (Treatments I and II) included corn-soybean-oat (Fig. 1). Each crop within Treatments I and II was grown in a 15 by 200 ft plot and rotated annually. The corn plot was then split into four 50-ft subplots to evaluate N fertilizer rates. Corn (24 000 seed/acre) and soybean (160 000 seed/acre) were planted in six 30-in. rows. Oat was sown at a rate of 120 lb/acre in 20 rows with 7.5-in. spacing using a no-till drill.

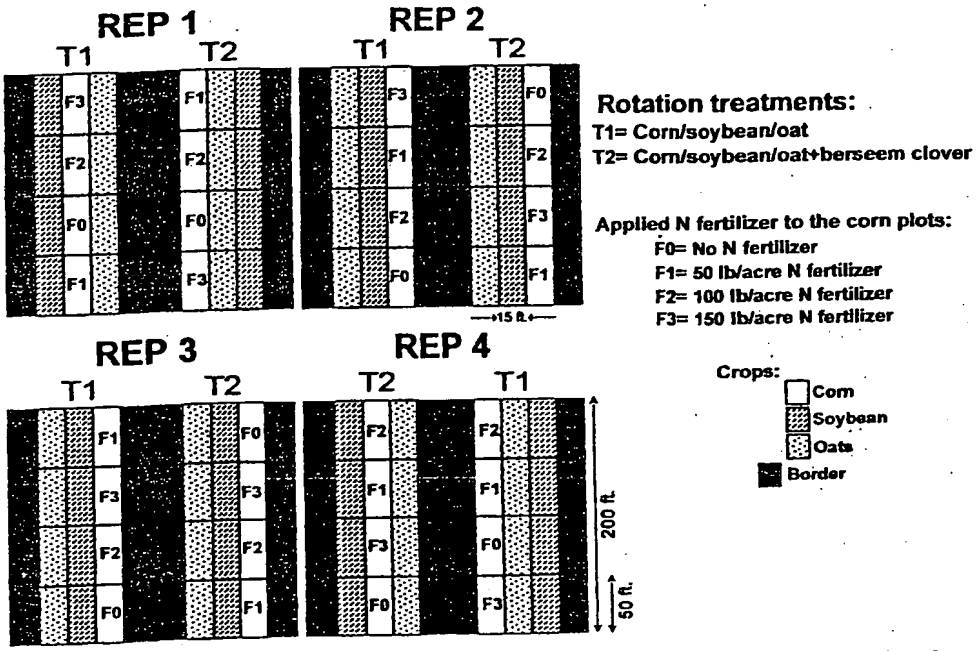

Fig. 1. Plot plan, rotation treatments, applied N fertilizer to the corn plots, plot and subplot sizes, and randomization of treatments within each replication.

Table 1. Monthly rainfall during growing seasons and accumulative rainfall during oat production (1991–1995).

Month	Rainfall by year					Departure from normal by year				
	1991†	1992‡	1993§	1994¶	1995#	1991	1992	1993	1994	1995
	in.									
April	6.86	3.60	3.45	2.29	3.99	+3.58	+0.32	+0.17	−0.99	+0.71
May	7.00	2.10	3.81	2.76	2.42	+2.83	−2.07	−0.36	−1.41	−1.75
June	6.14	2.12	6.95	6.57	6.74	+1.60	−2.42	+2.41	+2.03	+2.20
July	2.33	7.19	9.12	6.89	5.51	−2.01	+2.85	+4.78	+2.55	+1.17
August	4.93	2.65	8.70	2.17	5.74	+0.92	−1.36	+4.69	−1.84	+1.73
September	2.10	4.21	2.97	2.30	2.29	−1.90	+0.21	−1.03	−1.70	−1.71
October	4.11	0.88	1.41	3.39	2.30	+1.47	−1.76	−1.23	+0.75	−0.34
November	3.26	5.50	1.34	2.39	0.72	+1.60	+3.84	−0.32	+0.73	−0.94
Total	36.73	28.25	37.75	28.76	29.71	+8.09	−0.39	+9.11	+0.12	+1.07
During oat production	22.33	12.21	16.41	16.90	13.14					

† 1991—The wettest April in more than 40 yr.
‡ 1992—November received 3.8 in. more rain than normal, wettest in more than 40 yr.
§ 1993—Fourth wettest growing season in over 40 yr.
¶ 1994—Dry April and May, and above-normal rainfall in June and July provided excellent growing conditions.
# 1995—Hail on 22 July severely damaged corn and oat crops with minor damage to soybean crop.

For Treatment I, a mixture of oat (90 lb/ acre) and hairy vetch (27 lb/acre) was seeded as a true cover crop approximately 1 mo after oat harvest. The goals were to obtain soil cover and fixed N during the fall and spring and to kill the hairy vetch with 2,4-D after planting but prior to emergence of the subsequent corn crop in the spring. This failed miserably during spring of 1992 and the hairy vetch regrowth was killed with glyphosate before any substantial growth or apparent N_2 fixation occurred. Therefore, in Treatment I, seeding a cover crop was discontinued. The oat phase of this rotation is therefore referred to as sole-crop oat for the remainder of this discussion. No herbicide or fertilizer were applied to the oat crops.

For Treatment II, berseem clover was seeded at 15 lb/acre with 120 lb/acre of oats in spring. The oat cultivar for 1992 through 1995 was changed from a mid-season to short-season tall variety after extensive berseem clover growth interfered with oat grain harvest in 1991.

For both Treatments I and II, four N rates (0, 50, 100, and 150 lb N/acre) as ammonium nitrate (except in 1995, urea was used) were applied by hand to the corn subplots prior to first cultivation. Corn and soybean were both cultivated two or three times. In late August 1993, oat plots in Treatment I were tilled with a cultivator to control excessive weed growth after grain harvest. Pre-emergence weed control was accomplished by banding granular alachlor at planting. Phosphorus and K were not applied to any of the crops because the soil tested high for both nutrients.

Corn and soybean grain yields were determined by harvesting 40 ft of the two center rows of subplots using a small-plot combine. Grain yields were adjusted to the basis of 15.5 and 13% grain moisture for corn and soybean, respectively. Oat grain, straw, and biomass (minus grain) yields were determined by hand-harvesting 3 by 3 ft sections from the center of each subplot.

In Treatment II, at the time of oat grain harvest, berseem clover forage was separated from oat straw to determine straw-hay mixture ratio. Subsamples of oat straw and straw-hay were taken to the Iowa State University animal nutrient lab for in vitro evaluation of dry matter feed value using the direct acidification method (Marten and Barnes, 1980). Dry matter production from berseem clover regrowth was measured before the killing frost occurred each year. Plant material was dried and ground to pass a 0.04-in. screen with a Cyclone mill. Nitrogen concentration was determined by micro-Kjeldahl digestion (Bremner, 1965).

In many studies (Hargrove, 1986; Bruulsema and Christie, 1987; McVay et al., 1989) an indirect measurement of the legume cover crop's N contribution is determined by comparing yield response of the succeeding crop to N fertilizer with and without a cover crop. However, climatic conditions, nutrient uptake efficiency of the crop, N fertilizer type, and timing of application will affect the crop response to N fertilizer. To determine N fertilizer replacement values (NFRV) for the berseem clover cover crop, corn grain yield response to N fertilizer rates was used. Quadratic regression equations were obtained using corn grain yields following sole-crop oat (Treatment I) and oat intercropped with berseem clover (Treatment II). The NFRV was estimated by substituting 0 N rate grain yield for corn following oat underseeded with berseem clover into the quadratic equation of corn grain yield following sole-crop oats.

Statistical analyses were conducted using SAS (SAS Institute, 1985) analysis of variance procedures. A comparison of means was performed by using Fisher's LSD (the least significant difference at the 5% probability level) where significant treatment mean squares were found.

For economic evaluation, costs of oat production were estimated, using Cost of Crop Production in Iowa (Duffy and Judd, 1990–1995). Market-year average price (Iowa Agricultural Statistics, 1992–1996) and land value for Floyd County was used. For both treatments, production cost included: machinery, inputs, land value, and labor cost for oat grain and straw or hay (oat straw and berseem clover forage) harvest.

RESULTS AND DISCUSSION

Oat yields (1992–1995) were not affected by N fertilizer applied to corn plots in both rotations. Therefore, average yields of subplots for oat are presented. Total rainfall during oat production every year except in 1992 was above normal (Table 1).

Oat Grain and Biomass Yields

Oat grain yields in 1992, 1993, 1994, and 1995 were not significantly different for sole-crop plots and those interseeded with berseem clover (Fig. 2). In contrast, biomass (minus grain) production was 67, 150, 68, and 19% greater with berseem clover than without it from 1992 to 1995, respectively (Fig.2). High year-to-year variability of grain yield is a major reason why Iowa farmers grow very little oat. This variability was also evident in our field study. On the other hand, straw, and especially biomass (minus grain), production in the 5 yr was much less variable.

In 1992, the apparent soil productivity (2 yr of soybean 1990 and 1991) combined with excellent climatic condition resulted in record high oat grain production in Iowa. Oat grain production suffered in 1993 because of excessive rainfall. However, berseem clover biomass (minus grain) pro-

duction was 2.5 tons/acre at oat grain harvest (Fig. 2) and 1.4 tons/acre regrowth at the end of the growing season (Table 2). In 1995, hail damage in July caused severe oat grain loss and also moderately reduced berseem clover regrowth.

Most winter legume cover crops used in Iowa either delay planting or compete with the succeeding crop. Berseem clover, however, was winter-killed and presented no management obstacle for corn during next spring. In the 5 yr of this study, berseem clover has shown favorable intercropping characteristics with oat and seems adapted to the climatic conditions in Iowa. Feed quality of berseem clover forage and straw mix (oat straw 40% and berseem clover hay 60%) were high compared with straw with in vitro dry matter disappearance rates of 51 and 36%, respectively.

Oat Treatments Economics

Intercropping resulted in greater profits than sole-crop oat each year, primarily due to larger biomass (minus grain) production. In Treatment II, intercropping berseem clover with oat had better economic return than sole-cropped oat (Table 3). Additional costs of intercropping berseem clover included seed, extra baling, and labor costs. Production costs were not separated between oat grain and straw or hay production and only calculated as costs for a grain portion. Regrowth of berseem was left as a cover crop (green manure) to protect the soil and contribute N to the succeeding corn. The direct value of berseem clover regrowth or indirect value of contributed N to the following corn crops was not considered as profit.

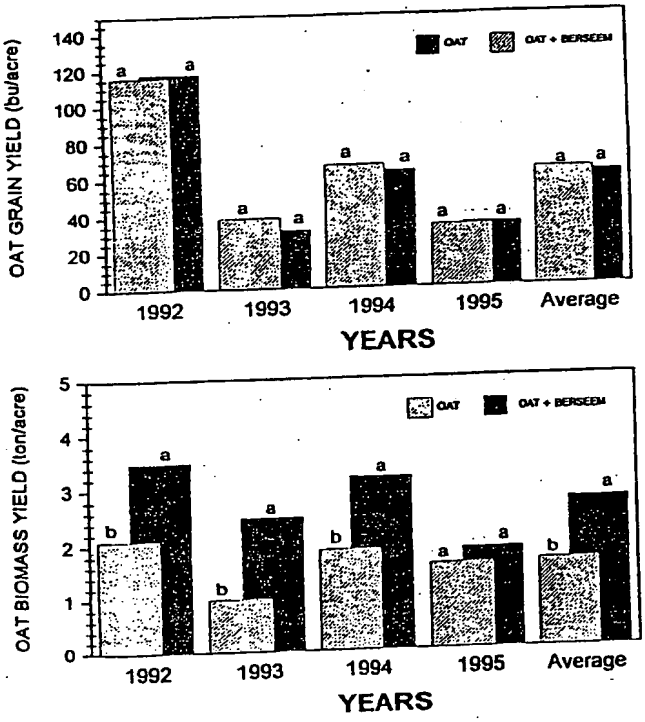

Fig. 2. Oat grain yield and biomass (minus grain) production at grain harvest time in both treatments. Yields with the same letter for a given year not different ($P > 0.05$).

Table 2. Primary oat crop planting, harvesting, and first killing frost occurrence, and potential N contribution of berseem clover from aboveground cover biomass.

	Date			Berseem clover regrowth		
	Oat		Killing			
Year	Planting	Harvesting	frost	DM†	N	N yield
				ton/acre	%	lb/acre
1991	7 Apr.	29 July	20 Sept.	1.3	2.49	65.0
1992	15 Apr.	19 July	5 Nov.	1.1	2.32	51.0
1993	10 May	30 July	29 Sept.	1.4	2.35	65.8
1994	11 Apr.	19 July	1 Nov.	1.2	2.41	57.8
1995	25 Apr.	20 July	22 Oct.	1.2	2.44	58.2
Means				1.2	2.40	59.6

† Dry matter was measured from aboveground biomass at the end of the cropping season.

Corn Yield

Corn responded similarly to applied N fertilizer in both rotation treatments. When N was not the limiting factor (150 lb N/acre subplots), corn grain yield (averaged for the 5 yr) was significantly higher for Treatment II than for Treatment I (Fig. 3). Above-normal rainfall, low air temperature, and below normal days of sunshine created poor growing conditions in 1993. Weed control problems (predominantly common dandelion [*Taraxacum officinal* W.]) in the 1994 corn plots after berseem clover resulted in relatively lower yield than in previous years. Hail in 1995 resulted in severe damage to corn leaves, which consequentially reduced grain yield by 35 to 40 %.

Soybean Yield

Adding berseem clover with oats had no effect on soybean yield (Fig. 2). Soybean yields also were not affected by N fertilizer applied to corn plots in both rotations. In 1995, soybean suffered 5 to 10 % hail damage.

Berseem Clover Nitrogen Content

Higher corn yields following oat plus berseem clover may be due to the N contribution of the legume cover. At the end of the growing season in 1991, 1992, 1993, and 1994, the amounts of berseem clover biomass that remained on the soil surface were 1.3, 1.4, 1.2, and 1.2 tons/acre, respectively. The N concentration of the dry matter was approximately 2.4% (Table 2). The potential N contribution of berseem clover from aboveground biomass was therefore consistent at approximately 60 lb N/acre per year. Determining N contribution to succeeding crops by calculating shoot biomass N content can be unclear (Heichel, 1987) because of potential N losses, tillage effects, and uncertain mineralization rates.

Estimations of NFRV for 1992, 1993, and 1994 by using corn response curves were 63, 165, and 0 lb N/acre, respectively. In 1995, corn plants were severely damaged by hail. This resulted in confounded grain response curves and estimates of NFRV were inconclusive. The N fertilizer rates were not sufficient to optimize corn grain yield in 1993 because above-normal precipitation and flooding resulted in a linear corn grain yield response to applied N. In 1994,

Table 3. Economic comparison of the oat production (at oat grain harvest) in both treatments at the Northeast Iowa Research Center (1991–1995).

Crops	Corn-Soybean-Oat					Corn-Soybean-Oat + Berseem					Years				
	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
											Price $/bu or ton†				
Oat-Grain											Grain				
Yield bu/acre	60	118	32	64	35	47	116	39	67	34					
Net $/acre	–$69	$15	–$98	–$56	–$88	–$129	–$33	–$128	–$90	–$124	$ 1.19	$1.34	$1.39	$1.41	$1.65
Straw						–	–	–	–	–	Straw				
Yield ton/acre	1.1	2.1	1.0	1.9	1.6	–	–	–	–	–	$45.00	$45.00	$50.00	$55.00	$62.00
Net $/acre	$50	$95	$50	$104	$99	–	–	–	–	–	Biomass (minus grain)				
Biomass (minus grain)						2.7	3.5	2.5	3.2	1.9	$50.00	$50.00	$55.00	$65.00	$75.00
Yield ton/acre	–	–	–	–	–	$135	$175	$137	$208	$142					
Net $/acre	–	–	–	–	–						Cost $/acre‡				
Total net profit/acre	–$19	$110	–$48	$48	$11	$6	$142	$9	$118	$18					
Total net profit/acre 5 yr			$20					$59			Oat + straw				
											$140§	$143	$143	$146	$146
											Oat+biomass(minus grain)				
											$185¶	$188	$182	$185	$180

† Market-year average price in Floyd County (Iowa Agricultural Statistics, 1992–1996)
‡ Total production cost (Duffy and Judd, 1990–1995).
§ Production cost included oat grain and straw harvest (but only calculated as cost for grain oat production).
¶ Production cost included oat grain, hay harvest, and extra cost associated with underseeded berseem clover (but only calculated as cost for grain oat production).

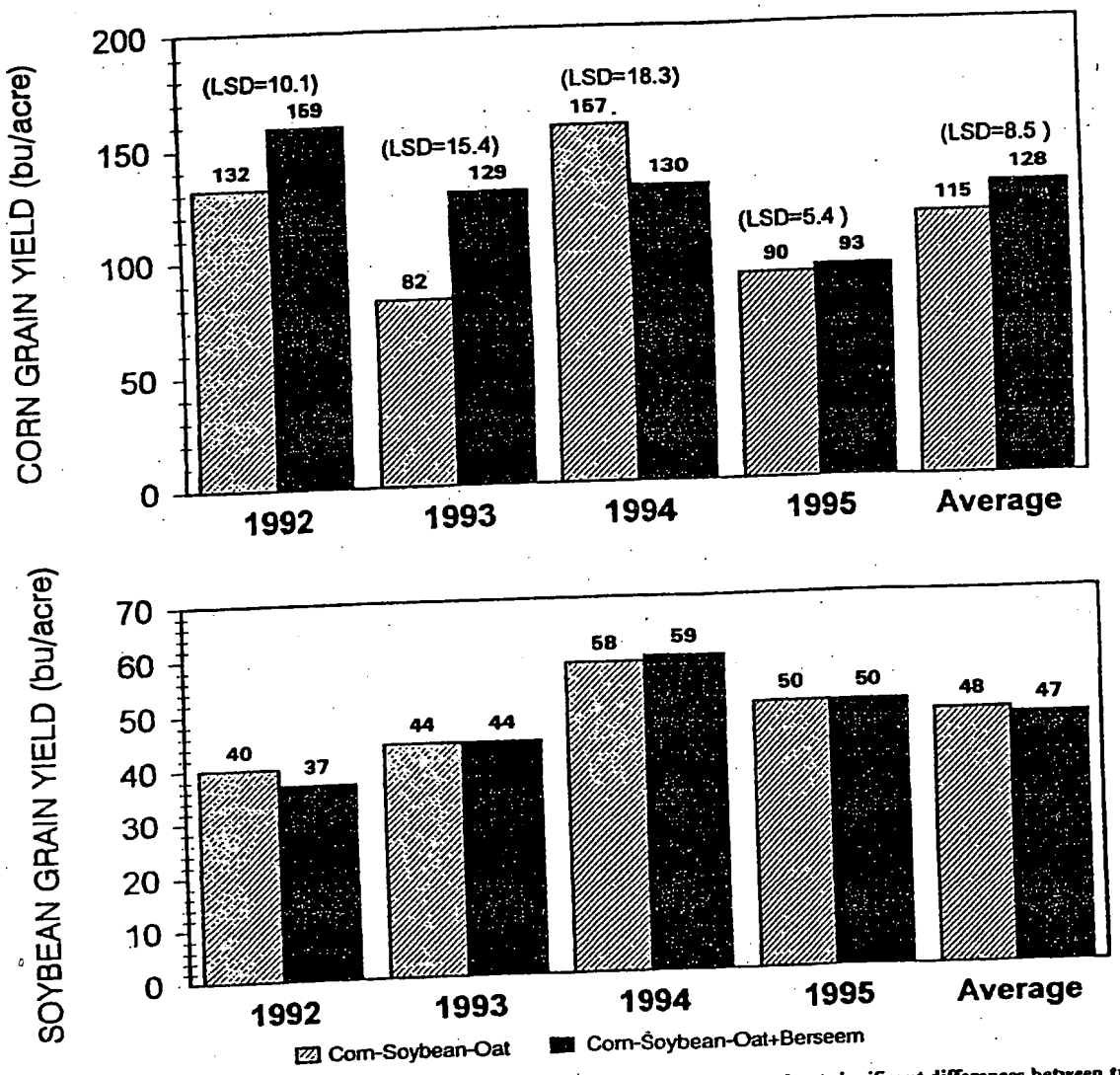

Fig 3. Corn and soybean yields for two rotation treatments in 1992, 1993, 1994, and 1995. LSD = least significant differences between treatments for each crop within a year.

response curves were similar in both treatments. Additionally, Treatment II had high weed pressure, which affected the corn grain yield. In 1992, a normal year, potential N contributed by the cover crop (aboveground portion) in fall and estimated NFRV from the succeeding corn crop were similar. Estimated NFRV using average corn grain (1992, 1993, and 1994) response curve to N fertilizer indicated that approximately 39 lb N/acre was contributed by berseem clover (Fig. 4).

The effect of a berseem cover crop on soil productivity and soil physical properties were not part of the research objectives; however, an adjunct study (Sawchik, 1994) indicated that berseem clover provided 79% groundcover until corn planting.

CONCLUSIONS

Intercropping berseem clover with oat increased total biomass production without reducing oat grain yield. Regrowth of berseem clover following oat harvest can be harvested for hay, fed as fresh green-chop, ensiled, grazed, or left as green manure. Using berseem as green manure to the cropping system provided the equivalent of 39 lb N/acre to a subsequent corn crop. Interseeding oat with berseem clover increased profit from the oat portion of a 3-yr corn-soybean-oat rotation by increasing biomass quality and quantity. Additionally, berseem clover provides a high-density cover crop, and improves soil productivity. The use of berseem clover as a cover crop could make growing oat more profitable and, with decreasing government payments, it may become a major viable alternative crop for farmers in the Midwest.

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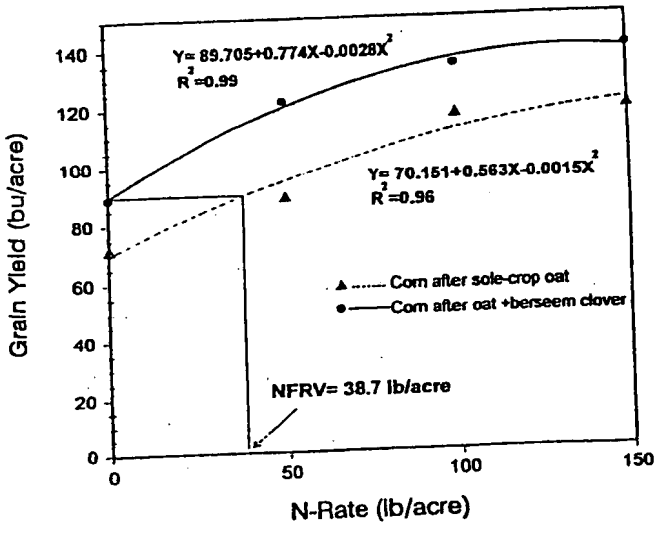

Fig. 4. Corn grain response to N fertilizer (1992, 1993, and 1994 average) and evaluation of N fertilizer replacement value (NFRV).

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Border Effects on Yields in a Strip-Intercropped Soybean, Corn, and Wheat Production System

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Strip-intercropping of corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] normally results in corn producing a negative border effect on soybean production. This study was conducted to determine whether including a small grain strip between corn and soybean strips could reduce the negative border effects of corn and enhance soybean yields. Corn, soybean, and wheat (*Triticum aestivum* L.) were grown as strip intercrops (15-ft wide) in a ridge-till system at two locations in southern Minnesota from 1991 through 1994 and were compared with a two-crop corn-soybean system. Rows were oriented east-west at one location and north-south at the other. Soybean yield in the three-crop system was reduced by 17% for the north row adjacent to corn and 8% for the south row next to wheat compared with nonborder east-west rows. In north-south rows, soybean yields were reduced by 21% in the east row next to corn compared with nonborder rows with no yield reduction in the west row next to wheat. In the two-crop corn-soybean strip system, soybean yields were reduced by 34 and 11% in the south and north border rows, respectively, compared with the nonborder rows in east-west rows. In north-south rows, the outside east row yielded 19% less and the west row yielded 21% less than the nonborder rows. Corn yield of the outside north row next to wheat in east-west rows was 6% greater while the south row next to soybean yielded 18% greater than the nonborder rows. In north-south rows, the east outside row next to wheat yielded 23% greater and the west row next to soybean yielded 27% greater than the nonborder rows. In the two-crop system, yield of the outside corn rows was enhanced similarly compared with the nonborder rows in both row orientations. Wheat yield in the 5-ft section next to soybean was 4% greater than the center 5-ft section and 6% greater than the 5-ft section next to corn in east-west rows and 9 and 17% greater in north-south rows. Results from this 4-yr study indicate that wheat planted between corn and soybean strips improved soybean production over the two-crop system without adversely affecting wheat yields. Corn production was enhanced by 9 to 12% in north-south rows and 2 to 7% in east-west rows in both the two- and three-crop strip systems.

STRIP INTERCROPPING is a practice in which two or more crops are grown simultaneously in contiguous strips. Alternating narrow strips of tall and short crops has been practiced infrequently for centuries, especially in small, intensive production systems and in developing countries. The goal has been to intercept sunlight more efficiently for maximizing crop production. In the USA, narrow alternate strip cropping systems are becoming more popular, probably because of reduced tillage systems (no tillage and ridge tillage) that easily accommodate management of strips.

In corn-soybean strip intercropping systems, both farmers (Hest, 1984; Holmberg, 1985; Klor, 1986; Reynolds, 1986) and researchers (Pendleton et al., 1963; Crookston and Hill, 1979; West and Griffith, 1992) observed that increased corn yields were offset by decreased soybean yields in the border rows. Radke and Burrows (1970) conducted a study using corn as a temporary windbreak in soybean fields in western Minnesota. They observed that soybean plants adjacent to corn windbreaks were not as productive as the rest of the windbreak-sheltered soybean due to shading and root competition from corn. Lesser soybean yields have been attributed to competition between corn and soybean for water, light, and nutrients due to the similarities in growth habits of the crops (Crookston and Hill, 1979).

A new approach to strip cropping, practiced by some farmers in the upper Midwest (Cramer, 1991; Mangold, 1992; Tonneson and Houtsma, 1991; Walter, 1991), introduces a

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room for a border strip between the two- and three-crop systems.

Corn 'Pioneer hybrid 3751' and soybean 'Sturdy' were planted on the same day in 30 in. rows with a six-row planter on ridges that were scalped to remove 1 to 2 in. of soil and the previous crop residue. Planting rate of the corn border rows (1 and 6) was increased by 20% above the nonborder rows (30 200 plants/acre) in an effort to maximize corn production within both the two- and three-crop systems. Soybean was planted at 9 to 10 seeds/ft of row. Spring wheat 'Grandin' was planted at 94 lb/acre directly into the soybean stubble without secondary tillage using a no-till drill following an application of 50 lb N/acre as ammonium nitrate. Each corn strip was subdivided into four 30-ft long plots and ammonium nitrate, was broadcast at rates of 0, 40, 80, and 120-lb N/acre. Starter fertilizer was not applied. Corn yields from only the 120-lb N/acre rate, which is close to the optimum N rate for corn after wheat and soybean, are presented and discussed in this paper. Phosphorus and K fertilizer were not applied due to high soil test levels of these nutrients. Corn and soybean strips were cultivated twice; with the second cultivation serving to build the ridges for the following year. Ridges were built when the corn and soybean reached about 20-in. height. Alachlor (3.0 lb ai/acre) and cyanazine (2.5 lb ai/acre) were tank-mixed and applied as preemergence herbicides for corn. For soybean, alachlor (3.0 lb ai/acre) was applied as preemergence and imazethapyr (0.06 lb ai/acre) was applied at the first trifoliate stage. All herbicides were applied in a 15-in. band. Bromoxynil (0.25 lb ai/acre) was broadcast to wheat before flagleaf stage to control broadleaf weeds.

Corn yield was determined by hand-harvesting 25-ft of each row. Soybean was harvested with a plot combine. Wheat yields were determined from each row by hand-harvesting a 15-ft long section. For the purpose of this paper, wheat grain yields were expressed for center and outside one-third sections, each 5-ft wide, by averaging yields from all seven rows for each section. Grain moisture at harvest was recorded for all three crops.

Relative grain yields for all corn and soybean rows, as well as the whole strip, were calculated by comparing the yields of each row to the center two rows within each six-row strip system. The experimental design was a randomized, complete block design with four replications. The effects of row position on grain yield and grain moisture were tested by analysis of variance with row positions and blocks as sources of variation for each year and location separately. In a combined analyses across the 4 yr, years and year × row position were also included as sources of variation within each location. The statistical analyses were performed using the general linear model procedure of SAS (SAS Inst, 1988). Row means were compared with single degree of freedom contrasts and Fisher's protected LSD at 5% level.

RESULTS AND DISCUSSION

Weather Conditions

Weather conditions during the growing season varied considerably among years but were similar at both locations (Table 1). Growing season was ideal in 1991, with abundant rainfall and warmer-than-normal temperatures. Rainfall was slightly below normal early in the growing season in 1992 and temperatures were colder than normal throughout the season. Conditions for plant growth were far from ideal in 1993, with excessive rainfall between May and August and cooler-than-normal air temperatures. Air temperatures in 1994 were above normal early in the growing season and again in September with cooler-than-normal July and August. Rainfall in 1994 was close to normal during the growing season, but below normal in May.

Soybean Yield

At the Waseca site with east-west rows, the north outside row next to corn yielded 17% less ($P \leq 0.01$) while the south outside row next to wheat yielded 8% less ($P \leq 0.01$) than the nonborder rows (Table 2). A combined analysis showed a significant ($P \leq 0.05$) effect of both years and year × row position interaction on soybean seed yield at Waseca. At the Freeborn site with north-south rows, the east outside row next to corn yielded 21% less ($P \leq 0.01$) than the nonborder rows, while the west outside row next to wheat yielded similar to the nonborder rows when averaged across years. Years had a significant effect ($P \leq 0.05$), while the year × row position interaction was nonsignificant in a combined analyses at Freeborn. Soybean yield in the row adjacent to corn was reduced on average by 10% ($P \leq 0.05$) at Waseca (east-west rows) and 18% ($P \leq 0.01$) at Freeborn (north-south rows) compared with the row next to wheat during the 4 yr. Fortin et al. (1994) also reported about 18% yield loss for the row next to corn compared with the row next to small grain in north-south rows. Seed size among the rows was very inconsistent with small seeds occurring in 2 of 6 site-yr in the row next to corn and larger seeds occurring in the row next to wheat in only 1 of 6 site-yr (data not shown). Other possible reasons for lesser yield of the outside soybean row are fewer pods and seeds per pod than in the nonborder rows.

In the two-crop system when both outside soybean rows were bordered by corn, row position influenced seed yield ($P \leq 0.05$) in all 7 site-yr (Table 3). The south outside row at Waseca yielded 34% less than the interior rows while the north row yielded 11% less during the 4 yr. Moreover, the outside south row yielded 25% less ($P \leq 0.01$) than the north row. The reason for the south row suffering more yield loss than the north row at Waseca is assumed to be due mainly to shading by the corn. At Freeborn, the east outside row yielded 19% less than the nonborder rows during the 3 yr, while the west outside row yielded 21% less in 2 yr. Yield differences were not significant between the two outside rows in the north-south rows.

Soybean yield in row 6 (adjacent to wheat) in the three-crop system (Table 2) was 8% less than the nonborder rows across years at Waseca and only 3% less at Freeborn. On the other hand, row 6 adjacent to corn in the two-crop system (Table 3) yielded 34% less across years at Waseca and 21% less at Freeborn. Thus, small grain resulted in less competition with the neighboring soybean row than corn, and soybean yields were greatly improved for the three-crop system. Root studies conducted in western Minnesota (Nelson and Allmaras, 1969; Radke and Burrows, 1970) showed corn roots proliferating into the adjacent soybean row and competing with soybean for moisture and nutrients. These researchers also observed very little intermingling of the roots from two adjacent soybean rows or two adjacent corn rows. This competition between adjacent corn and soybean roots may

Table 4. Corn yield in a corn-soybean-wheat strip-intercropping system at Waseca (east-west rows) and Freeborn (north-south rows).

Row	East-west rows					North-south rows				
	1991	1992	1993	1994	Average	1991	1992	1993	1994	Average
					bu/acre					
1 (next to wheat)	169.3	181.2	125.8	140.8	154.3	217.9	195.2	123.6	138.6	168.8
2	161.0	159.1	105.5	134.1	139.9	173.4	159.3	97.9	129.6	140.0
3	176.0	155.9	107.1	147.1	146.5	161.6	155.2	91.4	145.4	138.4
4	171.2	170.2	113.9	149.0	151.1	154.4	155.7	95.4	131.8	134.3
5	176.4	163.0	99.0	129.7	142.0	173.6	157.5	87.4	123.1	135.4
6 (next to soybean)	216.3	187.1	128.8	150.9	170.8	251.3	187.2	119.7	149.3	176.9
CV, %	5.3	7.0	8.5	10.6	7.8	10.8	8.4	9.0	12.8	10.6
LSD (0.05)	14.3	17.8	14.5	NS	8.3	30.8	21.4	14.0	NS	11.2
Row contrasts:										
1 vs. 2-5	NS	•	••	NS	••	••	••	••	NS	••
6 vs. 2-5	••	••	••	NS	••	••	••	••	NS	••
1 vs. 6	••	NS	NS	NS	••	•	NS	NS	NS	NS
2&5 vs. 3&4	NS	NS	NS	†	••	NS	NS	NS	NS	NS

•, ••, †, NS = significant at 0.05, 0.01, and 0.10 probability levels and not significant at 0.10 probability level, respectively.

Table 5. Corn yield in a corn-soybean strip-intercropping system at Waseca (east-west rows) and Freeborn (north-south rows).

Row	East-west rows				North-south rows			
	1991†	1992‡	1993†	1994‡	1991†	1992‡	1993†	1994‡
				bu/acre				
1	–	197.5	–	207.4	–	208.2	–	179.2
2	189.9	167.8	121.1	175.9	165.4	154.5	85.1	143.1
3	183.4	162.9	128.2	169.0	157.8	158.4	94.7	146.0
4	187.0	163.1	124.9	183.1	139.9	154.0	95.4	136.8
5	193.2	155.7	125.3	163.5	151.9	147.8	102.0	123.5
6	235.8	–	151.3	–	243.6	–	114.9	–
CV, %	6.3	8.6	6.5	6.2	5.7	6.6	11.3	8.0
LSD (0.05)	19.1	22.5	13.0	17.2	18.0	16.8	NS	21.9
Row contrasts:								
1 vs. 2-5	–	••	–	••	–	••	–	••
6 vs. 2-5	••	–	••	–	••	–	•	–
2&5 vs. 3&4	NS	NS	NS	NS	NS	NS	NS	NS

•, ••, NS = significant at 0.05, and 0.01 probability levels, and not significant at 0.10 probability level, respectively.
† Row 1 bordered corn and was not considered in the analysis.
‡ Row 6 bordered corn and was not considered in the analysis.

row at Waseca yielded 6% more while the south row yielded 18% more than the nonborder rows. This advantage for the outside corn rows could be due to a combination of better light interception and increased population in these rows. Greater yield advantage for the south outside row is thought to be due mainly to more direct sunlight reaching this row than the north row. This indicates that the yield advantage for strip intercropping is due mainly to the south row when in an east-west row orientation. On the other hand, at Freeborn with north-south rows, both the east and west outside rows benefitted by strip cropping. Averaged across years, yields of the east and west outside rows were 23 and 27% greater, respectively, than the nonborder rows. Unlike Waseca, yield differences were not significant between the outside east and west rows at Freeborn, probably because of similar amounts of sunlight reaching both outside rows.

Corn yields in the two-crop system were also influenced by row position in 7 of 8 site-yr (Table 5). At Waseca, the outside north row yielded 21% more than the nonborder rows, while the yield advantage for the outside south row averaged 23% above the nonborder rows. At Freeborn, the east outside row yielded 30 to 35% greater than the nonborder rows while the west outside row had a yield advantage of 58% in 1991 but only 22% in 1993 when yields were low and variable. When comparing the two- and three-crop systems in the same years (1991 and 1993), the corn row adjacent to soybean yielded 23% greater at Waseca and 40% greater at Freeborn than the nonborder rows in both cropping systems. This indicates that the outside corn row adjacent to soybean markedly and equally benefits both the two- and three-crop strip systems, especially when planted in a north-south row orientation.

Grain moisture at harvest of the outside north row next to wheat was significantly greater than the nonborder rows when averaged across years at Waseca (Table 6). On the other hand, the corn row next to soybean had significantly less grain moisture than the nonborder rows. Averaged across years, grain moisture in the south row was 4.2 percentage points

Table 6. Corn grain moisture at harvest in a corn-soybean-wheat strip-intercropping system at Waseca (east-west rows) and Freeborn (north-south rows).

Row	East-west rows					North-south rows				
	1991	1992	1993	1994	Average	1991	1992	1993	1994	Average
					%					
1 (next to wheat)	37.5	31.0	36.4	30.1	33.7	21.3	22.9	23.4	26.2	23.4
2	36.6	29.5	33.2	30.8	32.5	22.1	21.8	24.2	25.8	23.5
3	36.2	28.5	33.8	28.7	31.8	21.6	25.1	24.1	27.3	24.5
4	36.2	27.4	33.2	28.4	31.3	21.8	23.4	24.5	26.4	24.0
5	35.2	25.6	34.8	30.4	31.5	21.8	21.5	24.7	26.1	23.5
6 (next to soybean)	35.5	23.9	32.3	26.3	29.5	20.3	21.3	23.1	26.2	22.7
CV, %	1.6	5.2	6.2	4.7	4.6	3.4	4.4	4.8	6.3	5.0
LSD (0.05)	0.9	2.1	NS	2.1	1.0	1.1	1.5	NS	NS	0.8
Row contrasts:										
1 vs. 2-5	••	••	•	NS	••	NS	NS	NS	NS	NS
6 vs. 2-5	NS	••	NS	••	••	••	•	†	NS	••
1 vs. 6	••	••	•	••	••	†	•	NS	NS	†
2&5 vs. 3&4	NS	NS	NS	••	NS	NS	••	NS	NS	••

•, ••, †, NS = significant at 0.05, 0.01, and 0.10 probability levels and not significant at 0.10 probability level, respectively.

in an 11% yield loss at both locations. Whole strip corn yields were enhanced by 7 to 12% due to greater positive effects in the border rows in both row orientations in the two-crop system (Table 9).

CONCLUSIONS

Results from this 4-yr study indicate that under southern Minnesota conditions, wheat planted on the north side of corn in east-west rows and east of corn in north-south rows reduces negative border effects on soybean and improves the overall strip yields compared with a two-crop corn-soybean system. The soybean border row next to wheat benefitted more when planted in north-south rows than in east-west rows. Corn yields of the strips were considerably greater than whole-field yields due to positive border effects on outside rows, especially when planted in north-south rows. Energy costs for artificial drying could be reduced somewhat due to drier corn grain in both outside rows when intercrop strips are planted in a north-south row orientation. Although wheat yields were reduced slightly in the 5-ft section next to corn, the overall strip yields were unaffected due to strip cropping. These results suggest that alternate three-crop strips should be planted in a north-south row orientation rather than east-west to optimize production. However, economic conditions will determine the net benefit of farmers adopting this three-crop strip system rather than the two-crop system or the normal whole-field planting.

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Economic Analysis of Sustainable Agricultural Cropping Systems for Mid-Atlantic States

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ABSTRACT. This paper evaluates the profitability and economic risks associated with four cropping systems for the Sustainable Agriculture Demonstration site at Beltsville, Maryland, for the 1994-97 period. Each system follows a 2-year rotation of corn in the first year and winter wheat and soybean in the second year. The four systems are (1) a *no-tillage* system with recommended fertilizer and herbicide inputs, (2) a no-tillage system with *crownvetch* living mulch, (3) a no-tillage system with winter annual *cover crop*, and (4) a reduced tillage *manure-based* system without chemical inputs. The cover crop system is the most profitable ($238 in gross margin), closely followed by the no-tillage ($233) and the manure-based system ($217). Even though farmers desire a cropping system that maximizes profits, the variability of profits, or risks, can influence the desirability of the cropping system. In terms of risks, no-tillage is the most preferred rotation with the smallest coefficient of variation (1.14) followed by the cover crop system (1.24), the manure-based system (1.58), and the crownvetch system (5.45). The same ranking can be obtained using a "safety-first" criterion for risk-averse farmers, in which the gross margin of the no-tillage system would exceed \$53 ha^{-1} in three out of four years, while the gross margin of the cover crop system would exceed \$39 ha^{-1} in three out of four years. The manure-based system is an organic system and it was not profitable in 1996 and 1997 because of weed infestations. However, the manure-based system shows potential to be the most profitable if some methods can be found to control weeds without resorting to

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INTRODUCTION

In Mid-Atlantic states, most crops are grown on fields with steep slopes and soil erosion is a major threat to long-term productivity of agricultural lands. Reduced tillage helps reduce soil erosion. However, reduced-tillage systems often require more chemical fertilizer and herbicide inputs than conventional tillage and thus result in greater potential for water pollution. Therefore, the agricultural research community is challenged to develop profitable cropping systems that incorporate reduced tillage as well as reduced dependence on fertilizer and herbicide inputs.

Profitability is a major concern for farmers when they evaluate the sustainability of alternative cropping systems. A sustainable agricultural system must provide farmers with adequate profits. Otherwise, few farmers will adopt the sustainable system even if it is beneficial to the environment and to the natural resource base. Economic risks is also a major consideration when selecting a sustainable cropping system, and farmers respond to risks in different ways. Risk neutral farmers will select the cropping system that generates the largest expected (average) profit without regard to variability of profits, while risk averse farmers will accept smaller profits in exchange for more stable profits.

Several studies have been conducted to compare the economic impacts of conventional farming systems with those of alternative farming systems. However, the relative profitability of alternative systems to conventional systems is inconclusive. Ott and Hargrove (1989) evaluated the profitability and economic risks of using different cover crops (crimson clover, hairy vetch, winter wheat, and winter fallow) in no-tillage corn production based on three years of data from an agronomic cover crop experiment in Georgia. The authors used safety first criteria to identify cover crop strategies for farm operators with different risk attitudes. The authors found that no-tillage corn following hairy vetch generated the largest average profit. The authors also found that hairy vetch with 56 kg ha^{-1} N applied was the best strategy for risk-neutral farmers and hairy vetch with no N applied was preferred by risk-averse farmers. Hanson et al. (1993) conducted a 3-year field study in the Maryland Coastal Plain and Piedmont to assess the agronomic and economic characteristic of a hairy vetch cover crop on no-tillage corn. Their results indicated that at the corn price of \$94.50 MT^{-1}, corn following hairy vetch with additional 135 kg ha^{-1} N was the most profitable system in the Coastal Plain and corn following winter fallow with additional 45 kg ha^{-1} N was the most profitable system in the Piedmont. Using the safety-first criterion, the authors found that a hairy vetch cover crop system was the most desirable choice for risk averse farmers in both locations.

In South Dakota, Smolik et al. (1995) conducted two studies comparing the agronomic, economic, and ecological performance of alternative, conventional, and reduced-tillage farming systems over a 7-year period. Study I compared profitability of alternative, conventional, and ridge till farming systems. The alternative system consisted of a 4-year oats/alfalfa/soybeans/corn rotation with no chemical fertilizer and pesticide inputs. The conventional and ridge till systems each consisted of 3-year corn/soybeans/spring wheat rotations with recommended chemical fertilizer and pesticide inputs. The moldboard plow was used in the conventional system. In Study II, the alternative system consisted of a 4-year oats/clover/soybeans/spring wheat rotation with no commercial chemical and pesticide inputs. The conventional and minimum tillage farming systems each consisted of 3-year rotations of soybeans/spring wheat/barley with recommended chemical fertilizer and herbicide inputs. Only the conventional system used the moldboard plow. In Study I, the results indicated that the alternative system had the largest net returns, followed by the conventional and the ridge till systems. In Study II, the conventional system had slightly larger net income than the alternative system. The minimum tillage system was the least profitable.

In Iowa, proponents of alternative agriculture suggest that certain sustainable cropping systems can reduce soil erosion and water pollution without adversely affecting farmers' incomes. Producers are urged to use a legume crop in a rotation with row crops such as corn and soybeans. Foltz et al. (1993) assessed the economic and environmental implications of selected eastern Corn Belt farming systems using output from two process simulation models, EPIC and GLEAMS, combined with a farm level linear programming model. The results indicated that an alfalfa based cropping system was generally less profitable than a corn soybean rotation. Net returns were projected to decline by about 38 percent if alfalfa was included in an eastern Corn Belt cropping system.

Martin et al. (1991) used a linear programming model to determine relative profitability of crop rotations and weed management systems for three different farm sizes under alternative tillage systems. Their results showed that net incomes for no-tillage systems on all farms were consistently lower

than those for moldboard and chisel plow tillage systems, because of slightly smaller yields and substantially higher herbicide costs.

Concerns that conventional agriculture may pollute the environment and harm the natural resource base have prompted the Beltsville Agricultural Research Center to initiate several sustainable agricultural projects in Beltsville, Maryland. One of the major projects is the 6-ha Sustainable Agricultural Demonstration site on the South Farm, which has been designated to evaluate the efficacy of sustainable agricultural strategies that are compatible with reduced-tillage systems. The objective of this paper is to evaluate the profitability and economic risks associated with different cropping systems used in the Sustainable Agriculture Demonstration site.

MATERIALS AND METHODS

Site Description

The Beltsville Sustainable Agriculture Demonstration site was established on a 6-ha site with 2 to 15% slope on the South Farm of the Beltsville Agricultural Research Center. Five soil types were identified on this site: (1) coarse-loamy to loamy skeletal Typic Hapludult, (2) coarse-loamy Typic Hapludult, (3) fine-loamy Typic Hapludult, (4) fine-loamy to coarse-loamy Aquic Hapludult, and (5) coarse-loamy to fine-loamy Aeric or Typic Endoaquult (M. Rabenhorst, University of Maryland, personal communication). A corn-soybean rotation was used on the field for at least five years prior to establishment of the experimental plots.

Thirty-two plots, 9 m wide and approximately 150 m long, were established on a contour across the slope of the field and were separated by 2 m grass strips. Plots were laid out in the fall of 1992 and rotations were initiated in 1993. The first complete year of each cropping system began in the fall of 1993 with establishment of wheat and cover crops. Four cropping systems were established. Each cropping system followed a two-year rotation with corn in the first year and wheat/soybean double crop (with variations as noted below) in the second year. Corn was generally planted in early May, wheat in late October, and double-crop soybean in early July. Full-season rather than double-crop soybeans were planted in late May in one of the cropping systems.

The experimental design was a randomized complete block with four blocks. Each block contained four cropping systems assigned permanently to two plots. Plot pairs alternated between the corn and wheat/soybean phases of the rotation so that both phases of the rotation were present in every year for each cropping system.

DESCRIPTION OF CROPPING SYSTEMS

The four cropping systems established on the Sustainable Agriculture Demonstration site were developed with the expectation that (1) at least one grain crop would be harvested in every year, (2) crops would be rotated, (3) soil would be covered with vegetation during as much of the rotation as possible, and (4) tillage would be minimized. The no-tillage system with recommended inputs is representative of a typical system farmers in the mid-Atlantic states would use on highly erodible soils. The other systems employ alternative systems that may improve sustainability but that are not typically practiced in this area at present.

The no-tillage system represented recommended practices for no-tillage grain production in the mid-Atlantic states. Every planting provided a harvested crop with the intent of maximizing grain production during the two-year rotation. The absence of tillage and the presence of high residue level protected the soil against erosion. Fertilizer management followed the University of Maryland FERTREC program and herbicide applications were made according to University of Maryland recommendations. Postemergence herbicides were applied according to a zero-threshold philosophy so as to prevent weed seed production and reduce the weed seed bank.

The crownvetch system followed similar guidelines to the no-tillage system except that crops were grown in a perennial crownvetch living mulch. Crownvetch was planted at 5.6 kg ha^{-1} after wheat harvest in the first two years and allowed to establish during the remainder of those years rather than growing double-crop soybeans. The crownvetch was suppressed but not killed by herbicides applied before each crop. This living mulch was expected to reduce erosion and improve soil tilth and fertility.

The cover crop system used the winter annual species hairy vetch before corn and wheat before soybean. Since there was insufficient time to plant hairy vetch following a wheat/soybean double crop, a full-season soybean crop was grown between May and September to permit time to plant hairy vetch in October. Crops were planted into cover crops without tillage. Cover crop residues were expected to protect soil from erosion, improve soil moisture retention, and suppress early-season weed emergence. As a result, preemergence herbicides were eliminated and only postemergence herbicides were used as needed. In addition, hairy vetch is a legume and fixes atmospheric nitrogen for use by subsequent crops (Hanson et al., 1993). Thus hairy vetch was expected to provide nitrogen for corn, so preplant nitrogen application was eliminated. Only planter and sidedress nitrogen were applied.

The manure-based system is an organic system that eliminated all fertilizer, insecticide, and herbicide inputs. Cow manure provided nutrients for corn and wheat according to the University of Maryland MANUREC program

Crimson clover was overseeded into soybeans at last cultivation and provided additional green manure for corn. Manures were incorporated by chisel plowing and disking before planting. Weeds were controlled in corn and soybeans by rotary hoeing and cultivating with equipment designed to retain residue on the soil surface.

SOURCES OF DATA

Grain yields were determined by harvesting the middle eight rows of corn, five rows of wide-row soybean, nine rows of narrow-row soybean, and 3.8 m of wheat for the entire plot length and weighing in a weigh wagon. Grain yields were adjusted for moisture content of 15.5% for corn, 13.5% for wheat, and 13.0% for soybean. Wheat straw was baled from the entire plot after harvest.

Crop prices used were annual prices for the period 1994 through 1997 (Maryland Agri-Facts, various years). Since wheat grain was contaminated by wild garlic and could not be sold as milling quality, the annual price for wheat was adjusted to a feed grain price by taking the lesser of either the annual corn price plus \$19.68 MT^{-1} (\$0.50 bu^{-1}) or the annual wheat price. Nominal prices were adjusted to 1993 constant dollars using the Consumer Price Index. The price for wheat straw was held constant at \$105.84 MT^{-1} (\$1.20/25 pound bale) during all years.

The quantities of seeds, fertilizers, and chemicals used were actual values for the demonstration farm, with their respective prices. The typical custom hire charges represent 1993 prices for the state of Maryland (Johnson, 1993) and are used for all years and all blocks. The custom rate charges for 1996, block 1, are presented in Table 1. These charges were assumed to cover labor, machinery operating and depreciation costs, and associated insurance and taxes. Custom hire charges were used instead of breaking down individual operations and costing the components. Arguments can be made both that these charges underestimate and overestimate actual costs to farmers. Farmers' out of pocket costs cannot be determined from these charges.

Annual production costs for 1996, block 1, for the four cropping systems are detailed in Table 2. Seed, fertilizer, and chemical costs were provided by Johnson (1993) and are indicative of costs faced by farmers in 1994. Operating interest is for 6 months at an annual rate of 12%. Total variable production costs for each rotation are calculated as the simple average of the two rotation components (corn and wheat/soybean/straw), assuming that half the area is planted to each component. It is assumed that the farmer has both crop and livestock production and thus there is no cost for manure.

TABLE 1. Custom rate charges (\$/ha), 1996, Block 1.

			No-tillage		Crown vetch		Cover crop		Manure	
	units	price (\$)	amt	\$/ha	amt	\$/ha	amt	\$/ha	amt	\$/ha
CORN										
Spread manure	MT	2.21							21.28	47.03
Apply lime (incl. lime)	MT	26.40			0.28	7.39				
Spread fertilizer	ha	12.35	1	12.35	1	12.35	1	12.35		
Sidedress N	ha	14.80	1	14.80	1	14.80	1	14.80		
Chisel plow	ha	29.65							1	29.65
Disk	ha	24.70							2	49.40
Plant, no-till	ha	29.65	1	29.65	1	29.65	1	29.65	2	59.30
Plant hairy vetch, no-till drill	ha	37.00					1	37.00		
Overseed	ha	13.60							1	13.60
Spray	ha	12.35	1	12.35	2	24.70	1	12.35		
Rotary hoe	ha	19.80							1	19.80
Flail mow	ha	29.64					1	29.64		
Cultivate	ha	19.80							3	59.40
Combine	ha	61.75	1	61.75	1	61.75	1	61.75	1	61.75
Drying grain	MT	9.85	8.3	81.79	11.14	109.73	7.569	74.56	4.412	43.46
Hauling grain	MT	3.95	8.3	32.80	11.14	44.00	7.569	29.90	4.412	17.43
Total Custom Hire for Corn				\$245.49		\$304.38		\$301.99		\$400.82
WHEAT/SOYBEAN/HAY										
Spread manure	MT	2.21							16.8	37.13
Apply lime (incl. lime)	MT	26.40	0.56	14.78	1.68	44.35	2.24	59.14		
Spread fertilizer	ha	12.35	1	12.35	1	12.35	1	12.35		
Chisel plow	ha	29.65							2	59.30
Disk	ha	24.70							2	49.40
Plant wheat, drill	ha	24.70							1	24.70
Plant wheat, no-till drill	ha	37.00	1	37.00	1	37.00	1	37.00		
Plant soybeans, no-till	ha	37.00	1	37.00	1	37.00	1	37.00		
Plant soybeans, conventional	ha	29.65							1	29.65
Spray	ha	12.35	3.5	43.23	3	37.05	1	12.35		
Cultivate	ha	19.80							2	39.60
Combine	ha	61.75	2	123.50	2	123.50	1	61.75	2	123.50
Hauling grain	MT	3.95	5.59	22.07	6.175	24.39	3.93	15.50	4.877	19.27
Rotary mow	ha	29.64	1	29.64	1	29.64	1	29.64		
Flail mow	ha	29.64					1	29.64		
Bale straw	bale	0.35	193	67.43	185.3	64.84			108.7	38.04
Haul straw	bale	0.25	193	48.17	185.3	46.31			108.7	27.17
Total Custom Hire for Wheat/SB				\$435.16		\$456.43		\$294.37		\$447.75

RESULTS AND DISCUSSION

Yield Analysis

Weather was the major cause of yield variability over time. The weather conditions for 1994-1997 were extremely variable. In general, during 1994 and 1996 when uniform rainfall fell throughout the growing season, crop

TABLE 2. Production costs, 1996, Block 1.

			No-tillage		Crown vetch		Cover crop		Manure	
	units	price ($)	amt	$/ha	amt	$/ha	amt	$/ha	amt	$/ha
CORN										
Seed: corn	1000	0.90	64.96	58.46	64.961	58.46	64.96	58.46	133.1	119.80
hairy vetch	kg	0.59					28	16.62		
crimson clover	kg	0.95							22.4	21.32
Total Seed Costs				$58.49		$58.46		$75.09		$141.12
Fertilizer: N	kg	0.55	182.6	100.61	182.59	100.61	106.4	58.64		
P	kg	0.55	56.00	30.86	58.81	32.40	63.0	34.72		
K	kg	0.35	123.2	43.50	92.42	32.62	67.2	23.73		
Total Fertilizer Costs				$174.97		$165.64		$117.08		$0.00
Chemicals: Bicep	liter	9.51	5.606	53.31	5.606	53.31				
Gramoxone Ex	liter	9.56	1.752	16.75	1.752	16.75				
Accent	ml	0.94			48.7	45.78	48.7	45.78		
Banvel	liter	25.37					0.58	14.71		
Weedar64	ha	4.94	1	4.94						
Dual	liter	17.36								
Prowl	liter	7.30								
Surfactant	liter	4.40	0.73	3.21	1.46	6.42	0.73	3.21		
Total Chemical Costs				$78.21		$122.26		$63.70		$0.00
				$245.49		$304.38		$301.99		$400.82
Custom hire				$52.13		$59.83		$48.82		$40.98
Operating interest (12% p.a.)				$609.26		$710.57		$606.69		$582.92
Total Variable Costs per ha										
WHEAT/SOYBEAN										
Seed: wheat	kg	0.2600	134.4	34.95	134.424	34.95	134.4	34.95	134.4	34.95
soybean (old variety)	kg	0.3300	234.8	77.50	234.837	77.50			220	72.60
soybean (Roundup Ready)	kg	0.4162					220	91.56		
Total Seed Costs				$112.45		$112.45		$126.51		$107.55
Fertilizer: N	kg	0.55	100.8	55.55	67.21	37.03				
P	kg	0.55	89.76	49.46	115.52	63.65	57.41	31.63		
K	kg	0.35	58.81	20.76	67.21	23.73	86.82	30.65		
Total Fertilizer Costs				$125.77		$124.41		$62.28		$0.00
Chemicals: Harmony Ex	ml	0.43	73.04	31.41	36.54	15.70				
Gramoxone Ex	liter	9.56	1.752	16.75	3.504	33.50				
Dual	liter	17.36	2.336	40.55	2.336	40.55				
Lorox	kg	23.46	2.24	52.55	2.24	52.55				
Roundup	liter	11.89					4.672	55.55		
Poast	liter	29.07	0.88	25.58						
Surfactant	liter	4.40	1.46	6.42	1.46	6.42				
Crop oil conc.	liter	1.42	1.17	1.66						
Total Chemical Costs				$174.93		$148.73		$55.55		$0.00
				$435.16		$456.43		$294.37		$447.75
Custom hire				$75.69		$73.66		$46.98		$39.77
Operating interest (12% p.a.)				$923.99		$915.68		$585.69		$595.07
Total Variable Costs per ha										
TOTAL VARIABLE COSTS PER HA ROTATION				$766.63		$813.12		$596.19		$589.00

yields for all cropping systems were higher than those in the dry years of 1995 and 1997. Drought in 1997 was especially severe; it was the worst drought in the last 50 years.

Corn yields for the four cropping systems from 1994 through 1997 are presented in Table 3a. No single cropping system had the highest average corn yield for all crop years. The cover crop had the highest yields in 1994 and 1997, the crownvetch system had the highest yield in 1996, and no-tillage yielded the highest in 1995. Corn yields for the manure-based system declined considerably in 1996 and 1997 relative to the better yielding treatments because of increased weed competition in those two years. On the average, the cover crop system had the highest average yields followed by no-tillage, crownvetch, and the manure-based system.

Table 3b shows wheat yields for the four cropping systems from 1994 through 1997. The crownvetch system had the highest wheat yields in 1994, 1996, and 1997, but the manure-based system had the highest yield in 1995. Poor wheat yields for the manure-based system in 1996 and 1997 were again due to increased weed competition in those two years. When averaging across years, the crownvetch system had the highest wheat yields, followed by the no-tillage system and the manure system.

TABLE 3a. Corn yields (MT/ha), 1994-97.

	Block	1994	1995	1996	1997	Mean	C.V.
No-tillage	1	10.82	5.06	8.30	2.46	6.66	
	2	10.95	8.12	11.54	4.24	8.71	
	3	11.63	6.71	10.10	2.25	7.67	
	4	11.35	6.61	11.90	3.09	8.24	
	Mean	11.19	6.62	10.46	3.01	7.82	0.49
Crownvetch	1	7.44	3.01	11.14	1.38	5.74	
	2	7.97	2.87	12.31	0.19	5.84	
	3	9.60	4.10	12.55	1.07	6.83	
	4	9.40	4.53	12.69	2.71	7.33	
	Mean	8.60	3.63	12.17	1.34	6.44	0.76
Cover crop	1	10.91	6.72	7.57	5.34	7.64	
	2	11.92	7.32	11.45	5.26	8.98	
	3	12.21	6.39	9.51	2.85	7.74	
	4	11.24	4.40	10.69	2.05	7.10	
	Mean	11.57	6.21	9.80	3.88	7.86	0.46
Manure	1	7.71	6.49	4.41	2.26	5.22	
	2	9.04	5.50	6.31	0.34	5.30	
	3	9.86	6.34	6.85	1.32	6.09	
	4	10.38	6.77	5.91	1.01	6.02	
	Mean	9.25	6.27	5.87	1.23	5.66	0.6

TABLE 3b. Wheat yields (MT/ha), 1994-97.

	Block	1994	1995	1996	1997	Mean	C.V.
No-tillage	1	1.311	3.247	4.001	1.812	2.593	
	2	3.089	3.123	4.511	3.123	3.462	
	3	2.909	4.117	3.455	3.064	3.386	
	4	1.158	4.273	3.710	3.513	3.164	
	Mean	2.117	3.690	3.919	2.878	3.151	0.326
Crownvetch	1	4.248	3.121	4.246	3.790	3.851	
	2	4.090	3.150	4.728	4.310	4.069	
	3	5.224	3.604	4.867	4.590	4.572	
	4	3.759	3.681	4.069	3.640	3.787	
	Mean	4.330	3.389	4.478	4.083	4.070	0.137
Manure	1	3.088	3.324	3.022	1.182	2.654	
	2	3.170	4.279	2.838	1.893	3.045	
	3	3.970	4.931	2.772	2.469	3.536	
	4	3.756	4.683	2.521	1.872	3.208	
	Mean	3.496	4.304	2.789	1.854	3.111	0.353

Yield variability is also important in determining which cropping system to use. Both the standard deviation and the coefficient of variation are commonly used to measure variability, but the coefficient of variation is a better measurement when the means differ considerably. Thus, the coefficient of variation is used to measure yield variability. We used data from each block in each year (16 observations) to determine variability in both space and time. As shown in Table 3a, the cover crop system, which had the highest average corn yield, also had the smallest coefficient of variation (0.46), followed by the no-tillage (0.49), the manure-based (0.60), and the crownvetch systems (0.76). According to Table 3b, the crownvetch system had the smallest variability for wheat yield followed by the no-tillage and manure-based systems, as measured by the coefficient of variation.

Soybean yields were not analyzed here because no soybeans were harvested from the manure system in 1994 due to excess competition from weeds and no double-cropped soybeans were harvested in 1997 because of drought. However, the costs for growing soybeans were included in the economic analysis.

Economic Analysis

Table 4 shows total returns, variable costs, and gross margins for 1996, block 1. This Table represents one of the 16 tables with one table for each block and each year. We assume that both years of the rotation are represented in a hectare and thus the returns by crop shown in the Table are for a

TABLE 4. Costs, returns, and gross margins, 1996, Block 1.

	No-tillage	Crown vetch	Cover crop	Manure
RETURNS (per ha)				
Corn	441.39	592.19	402.36	234.54
Winter wheat	235.27	249.69	0.00	177.73
Wheat straw	109.28	89.89	0.00	61.22
Soybean	201.11	244.57	497.67	235.20
Total Returns	$987.06	$1,176.35	$900.03	$708.69
VARIABLE COSTS (per ha)				
Seeds	85.46	85.46	100.80	124.34
Fertilizers	150.37	145.02	89.68	0.00
Chemicals	126.57	135.50	59.63	0.00
Custom hire	340.33	380.41	298.18	424.28
Operating interest (12% p.a.)	63.91	66.74	47.90	40.38
Total Variable Costs	$766.63	$813.12	$596.19	$589.00
TOTAL GROSS MARGIN ($/ha)	$220.43	$363.23	$303.83	$119.69

half hectare. Total returns are simply the sum of returns of the individual crops. Gross margin is the total returns less total variable costs.

Gross margins for the four cropping systems from 1994 to 1997 are summarized in Table 5. For the average of four years, the cover crop system provides the greatest gross margins ($238.28 ha^{-1}), partly because of the highest average corn yields, followed by the no-till system ($233.27) and the manure-based system ($217.35 ha^{-1}). The average gross margin for the crownvetch system is the lowest ($53.34 ha^{-1}).

The manure-based system returned more gross margins than all other systems during 1994 and 1995 but had the smallest gross margins during 1996 and 1997. Poor crop yields in the last two years due to increased weed competition contributed to smaller gross margins. The manure-based system could become more profitable relative to the other three systems if weeds could be controlled. Also, the manure-based system has the potential to become the most profitable of the four systems, since its crops can be certified as organic and sold at premium prices.

Risk Analysis

Farming is a risky business, and farmers are constantly facing uncertainty due to unpredictable factors such as price variability, weather, diseases, pests, etc. Generally, farmers want to select a cropping system that generates the largest profits, but the variability of profits, or economic risks, can also affect the desirability of the cropping system. Farmers respond to risks in different ways. A risk neutral farmer will select the cropping system that generates the

TABLE 5. Gross margins, coefficients of variation, and safety-first lower limits.

		1994	1995	1996	1997	Mean	C.V.	Lower Limit
		$/ha	$/ha	$/ha	$/ha	$/ha		$/ha
No-tillage	1	307.97	214.15	220.43	−259.16	120.85		
	2	555.64	355.62	500.56	−57.18	338.66		
	3	491.49	328.58	284.57	−188.19	229.12		
	4	356.66	275.92	444.04	−98.81	244.45		
	Mean	427.94	293.57	362.40	−150.83	233.27	1.14	53.31
Crown vetch	1	−40.36	−139.74	363.23	−229.07	−11.49		
	2	−32.14	−149.98	470.86	−203.76	21.24		
	3	131.77	−29.81	552.20	−177.40	119.19		
	4	14.36	0.86	479.05	−156.59	84.42		
	Mean	18.41	−79.67	466.33	−191.71	53.34	5.45	−142.54
Cover crop	1	430.47	216.40	303.83	39.43	140.63		
	2	569.50	233.34	517.95	−103.95	304.21		
	3	528.46	229.54	434.65	−97.98	273.67		
	4	439.37	−1.88	404.93	−331.53	127.72		
	Mean	491.95	169.35	415.34	−123.51	238.28	1.24	39.21
Manure	1	391.19	320.51	119.69	−248.99	145.60		
	2	458.05	374.49	207.45	−285.20	188.70		
	3	580.20	530.05	225.72	−189.54	286.61		
	4	612.13	507.46	124.70	−250.24	248.51		
	Mean	510.39	433.13	169.39	−243.49	217.35	1.58	−14.38

largest expected (or average) profit without regard to variability of profits. In this study, a risk neutral farmer would prefer the cover crop system, since it generates the largest average gross margin of the four systems evaluated. Alternatively, a risk averse farmer is more concerned with the variability of profits and would be willing to sacrifice higher profits to achieve more stable profits. Table 5, column 8, shows the coefficients of variation for the four cropping systems. The no-tillage system provides the smallest coefficient of variation (1.14) followed by the cover crop system (1.24), the manure-based system (1.58), and the crownvetch system (5.45).

Another way to evaluate risks is the safety-first criterion (Musser et al., 1981; Hanson et al., 1993). This method is consistent with maximizing expected profits, where profits are used as a proxy for utility (Selley, 1984). The coefficient of variation measures the extent that profits deviate from the mean, both upward and downward. However, farmers are concerned about the downward deviations and not the upward deviations. The safety-first criterion assumes that the decision maker wants to maximize profits subject to the probability that profits will be greater than a specified disaster level. For empirical applications, the lower confidence limit of profits has been used to specify the disaster level. The lower confidence limit of profits for a particular activity, the ith cropping system in this case, can be calculated as

$$L_i = E_i - K\sigma_i$$

where

E_i = expected profits

K = the number of standard deviations required to impose the desired probability that E_i is greater than L_i

σ_i = the standard deviation of profits for activity i.

Assume that profits are normally distributed. For K = 0.6745 in a normal distribution, the probability that gross margins will be greater than or less than $K\sigma_i$ from the mean is 50 percent. That is, the probability that the gross margin will be below $L_i = E_i - K\sigma_i$ is 25 percent and the probability that the gross margin will be above $U_i = E_i + K\sigma_i$ is 25 percent (where U_i is the upper confidence limit). Farmers are only concerned with the lower limit. Thus, the farmer can expect to have profits at least $\$L_i$ in three out of four years. For example, the mean and standard deviation of gross margins for the no-tillage system are \$233.67 ha^{-1} and \$267.00 ha^{-1}, respectively. At the 75 percent confidence interval, the lower confidence limit for the no-tillage system is \$53.31 ha^{-1}. That means the farmers can expect to receive a gross margin of at least \$53.31 ha^{-1} in three out of four years using the no-tillage system.

The last column of Table 5 shows the lower limits of gross margins at the 75% risk confidence level for the four cropping systems. These results support the previous results using the coefficients of variation in that the no-tillage system has the smallest risks. Three out of four years, the average gross margins for the no-tillage system are expected to exceed \$53.31 ha^{-1} as indicated above. The cover crop system has the second smallest risks with the lower confidence limit of \$39.21 ha^{-1}, followed by the manure-based system with a −\$14.38 ha^{-1} lower confidence limit. Crownvetch has the largest risks with the confidence limit of −\$142.54 ha^{-1}.

The risks measured for the 1994-1997 period probably overestimated the variability of crop yields in the Mid-Atlantic states. Weather conditions during this period were the extremely variable, ranging from unusually good years in 1994 and 1996 to an extremely dry year in 1997. Therefore, results of economic and risk analyses based on the four years of yield data can not be considered "typical" or "representative." Different ranking of profits and risks could emerge for a typical or representative year. More data are needed to assess long-term profitability and risks.

Sensitivity Analysis

The relative profitability of the four cropping systems depends on relative prices, especially the input prices. The four systems use different sources of nitrogen. The no-tillage and crownvetch systems use chemical fertilizers, the cover crop system uses hairy vetch, and the manure-based system uses ani-

crop system is second best in terms of economic risk, followed by the manure-based and crownvetch systems. These results differ from those reported by Hanson et al. (1993) and Ott and Hargrove (1989), where corn and hairy vetch cover crop systems were found to be preferred by risk-averse farmers in most instances. A likely reason for the different economic risk findings is that the cropping systems in our study harvest soybeans and winter wheat also, whereas Hanson et al. (1993) and Ott and Hargrove (1989) focus on monocropped corn with cover crops grown between corn harvest and planting.

Several key points and limitations need to be mentioned in order to properly interpret the results of this study. First, weather conditions during the 1994-1997 period were extremely unusual and thus the results of the economic and risk analyses based on the four years of yield data can not be considered "typical" or "representative." More data are needed to assess long-term profitability and risks. In a separate paper, we will use a simulation model to evaluate the four cropping systems studied in this paper along with other systems under different weather conditions.

Second, the results of our study may be considered applicable to the mid-Atlantic and Southeastern states of the U.S. due to the cover crops evaluated. Legume crops such as hairy vetch and crimson clover preform poorly in cold environments. Low winter temperatures less than $-15°C$ can reduce or eliminate the legume stand (Allison and Ott, 1987). Consequently, cropping systems with hairy vetch or crimson clover may be inappropriate for some northern regions of the U.S. Also legume cover crops may reduce soil moisture in the spring and may leave insufficient moisture to adequately germinate grain crops during dry weather conditions (Allison and Ott, 1987). Thus, cropping systems with legume cover crops may be inappropriate for some western regions of the U.S. where winter fallow is practiced to conserve soil moisture in rain-fed agriculture.

Finally, environmental impacts of these systems were not evaluated in this study. Other long-term objectives such as reduced soil erosion, reduced fertilizer losses, and reduced pesticide hazards must be considered along with profitability and economic risk when identifying sustainable agricultural cropping systems. These objectives are often in conflict with one another (Kelly et al., 1996). Future research will take these objectives into account.

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RECEIVED: 08/27/
REVISED: 02/22/
ACCEPTED: 03/04/

This postal card acknowleges the PTO's receipt of the following:

1. 51 consecutively page numbered first office action reply; attached appendix with three
2. prior art research articles

3. fee sheet, extension of time sheet; and transmittal sheet;

4. check number 4563 for $60.00 payable to the U. S. Com'r for Patents

Inventor: Marvin J. Williams, Jr; Application No. 10/747,728; filing date: 12-29-2003; Art Unit: 3643; Examiner: J.L. Gellner; Attorney of Record: Adrienne B. Naumann; phone: 847-329-8185;fax: 847-329-8750;U.S.Express Mail No. EQ 002003 755 US

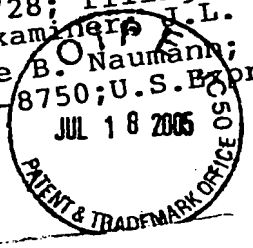

Exhibit C

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/747,728	12/29/2003	Marvin J. Williams JR.		2033

31156 7590 02/10/2006

LAW OFFICE OF ADRIENNE B. NAUMANN
8210 NORTH TRIPP
SKOKIE, IL 60076

EXAMINER	
GELLNER, JEFFREY L	

ART UNIT	PAPER NUMBER
3643	

DATE MAILED: 02/10/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/747,728	Applicant(s) WILLIAMS, MARVIN J.	
	Examiner Jeffrey L. Gellner	Art Unit 3643	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Specification

In the "BRIEF DESCRIPTION OF THE DRAWINGS" section the term "wheat grass" should probably be --wheat-- so as to not be confused with wheatgrass, *Agropyron* spp. The term "wheat grass" is used occasionally in the Specification and should be changed to --wheat--.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1-20 are rejected under 35 U.S.C. 112, first paragraph, as based on a disclosure which is not enabling. In the independent claims, the harvesting of the first portion of the annual green crop and its mixing to become a combined green manure is critical or essential to the practice of the invention, but not included in the claim(s) is not enabled by the disclosure. See *In re Mayhew*, 527 F.2d 1229, 188 USPQ 356 (CCPA 1976). The independent claims recite "spraying said first portion of said combination mulch" but there is no step between mowing the annual green manure and harvesting and combining the its first portion to arrive at the combination mulch so it can be sprayed.

Allowable Subject Matter

Claims 1-20 are allowed over the art of record.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Warman and Tonhasca et al. disclose in the prior art various green manure/intercropping techniques.

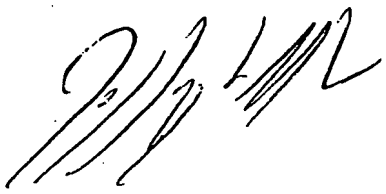
THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeffrey L. Gellner whose telephone number is 571.272.6887. The examiner can normally be reached on Monday-Friday, 8:30-4:00, alternate Fridays off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Peter Poon can be reached on 571.272.6891. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Jeffrey L. Gellner
Primary Examiner
Art Unit 3643

PTO/SB/08b (08-03)
Approved for use through 06/30/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

	Complete if Known
Application Number	10/749726
Filing Date	12-29-2003
First Named Inventor	Marvin J. Williams,Jr.
Art Unit	
Examiner Name	
Attorney Docket Number	---

Sheet 1 of 1

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		quik-Change Attachments, brochure page	
		KINZE[R] planter, brochure page	
		Kuhn Cultirotor/Cultiplow,Cultitiller,EL201 catalogue	
		Kuhn Power Riller/Cultiplow/Cultitiller EL. 100N, catalogue	
		DuPont Corn and Soybean Solutions Guide, booklet	

Examiner Signature		Date Considered	6/15/06

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
1 Applicant's unique citation designation number (optional). 2 Applicant is to place a check mark here if English language Translation is attached.

Notice of References Cited	Application/Control No. 10/747,728	Applicant(s)/Patent Under Reexamination WILLIAMS, MARVIN J.	
	Examiner Jeffrey L. Gellner	Art Unit 3643	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
W	A	US-			
	B	US-			
	C	US-			
	D	US-			
	E	US-			
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	L	US-			
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FOREIGN PATENT DOCUMENTS

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	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Waman. 1991. Effect of incorporated green manure crops on subsequent oat production in an acid, infertile silt loam. Dev. Plant Soil Science 45: 431-435.
	V	Tonhasca et al. 1991. Effects of strip intercropping and no-tillage on some pests and beneficial invertebrates of corm in Ohio. Environmental Entomology 20: 1251-1258.
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

PTO/SB/08b (08-03)
Approved for use through 06/30/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

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Application Number	10/744726
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First Named Inventor	Marvin J. Williams,Jr.
Art Unit	
Examiner Name	
Attorney Docket Number	---

Sheet 1 of 1

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		quik-Change Attachments, brochure page	
		KINZE[R] planter, brochure page	
		Kuhn Cultirotor/Cultiplow,Cultitiller,EL201 catalogue	
		Kuhn Power Riller/Cultiplow/Cultitiller EL 100N, catalogue	
		DuPont Corn and Soybean Solutions Guide, booklet	

Examiner Signature		Date Considered	6/15/05

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1 Applicant's unique citation designation number (optional). 2 Applicant is to place a check mark here if English language Translation is attached.

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Examiner	Art Unit	Page 1 of 1
Jeffrey L. Gellner	3643	

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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Waman. 1991. Effect of incorporated green manure crops on subsequent oat production in an acid, infertile silt loam. Dev. Plant Soil Science 45: 431-435.
	V	Tonhasca et al. 1991. Effects of strip intercropping and no-tillage on some pests and beneficial invertebrates of corn in Ohio. Environmental Entomology 20: 1251-1258.
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

*527 F.2d 1229, *; 1976 CCPA LEXIS 202, **;*
188 U.S.P.Q. (BNA) 356

IN THE MATTER OF THE APPLICATION OF JOHN T. MAYHEW

Patent Appeal No. 74-608

UNITED STATES COURT OF CUSTOMS AND PATENT APPEALS

527 F.2d 1229; 1976 CCPA LEXIS 202; 188 U.S.P.Q. (BNA) 356

January 15, 1976

PRIOR HISTORY: [**1] Serial No. 46,825.

CASE SUMMARY

PROCEDURAL POSTURE: Appellant sought review of the decision of the United States Patent and Trademark Office Board of Appeals rejecting appellant's claims in a patent application pursuant to 35 U.S.C.S. § 112.

OVERVIEW: Appellant inventor filed claims in a patent application for a production method for an iron-zinc alloy coating. The majority of appellant's patent claims were rejected under 35 U.S.C.S. § 112. Appellant sought review of the decision. The court affirmed in part and reversed in part and held that the specification failed to support appellant's contention that a cooling bath was optional. The court found the cooling bath and its location were essential but that appellant failed to recite them in his specification. Therefore, the claims that failed to recite the cooling bath or its specific location were rejected. However, claims that failed to recite the temperature of the cooling bath were improperly rejected under § 112. After reading the claims in light of the specification, the court found that the general function of the cooling bath was clear and one of ordinary skill in the art would be able to select the appropriate temperature. The cooling bath was meant to accomplish numerous functions and the functions were dependent on a number of variables. Therefore, the temperature depended on the function.

OUTCOME: The court affirmed in part and reversed in part the rejection of appellant's patent claims and held that appellant's failure to recite the temperature of the cooling bath was not fatal to his claims.

CORE TERMS: bath, strip, zone, invention, specification, spelter, temperature, cooling, examiner, subject matter, molten, steel, galvanizing, cooled, exit, alloy, disclosure, coating, patent, distinctly, iron-zinc, coated, recite, oxygen, enabling, iron, penetration, specially, deep, practicable

LexisNexis(R) Headnotes ◆Hide Headnotes

Patent Law > U.S. Patent & Trademark Office Proceedings > General Overview
Patent Law > Jurisdiction & Review > Subject Matter Jurisdiction > Appeals
Patent Law > Claims & Specifications > Enablement Requirement > General Overview
HN1 35 U.S.C.S. § 112(1) requires that patent claims be supported by an enabling disclosure.

Patent Law > Jurisdiction & Review > Subject Matter Jurisdiction > Appeals
Patent Law > Claims & Specifications > Claim Language > General Overview
HN2 The language employed in a patent claim must always be analyzed in

light of the specification.

OPINIONBY: RICH

OPINION: [*1230]

RICH, Judge.

This appeal is from the decision of the Patent and Trademark Office Board of Appeals sustaining the examiner's rejection of claims 1-27, 29-48, 51, and 52 of application serial No. 46,825, filed June 16, 1970, for "Method of Producing Iron-Zinc Alloy Coated Steel Strip and Product Thereof." The final rejection indicated that claims 49 and 50 would be allowable if in independent form. We affirm in part and reverse in part.

The original decision herein was handed down March 13, 1975, reaching the same result we now reach. March 28, 1975, appellant filed a Petition for Rehearing which we granted. Further oral argument was held October 8, 1975.

Our former opinion, withheld from publication, is hereby withdrawn. The following is the opinion of the court.

The Invention

The invention of all appealed claims but two is a method for the production of a corrosion-resistant, iron-zinc alloy coating on a steel strip. Referring to Fig. 2 of appellant's drawing, reproduced below in slightly modified form,

[Graphic omitted. See illustration in original.] [*1231]

steel strip 16 is heated to approximately 1000 [**2] degrees F. or greater, ordinarily considered higher than optimum, and passed, in the direction of the arrow, into a molten bath 56 of spelter of about 99% zinc containing up to .30% aluminum. The bath, "except for a defined minor portion specially located at its exit side, is maintained at approximately 900 degrees F. to 950 degrees F. or higher" by heat from strip 16 and other heat sources such as 63, as needed.Iron-zinc alloy is formed on the strip while it is submerged. After the strip passes around sink roll 50, the strip, now designated 52, travels into cooled spelter zone 54, containing coolers 56', 58, 60, and 62 which control the temperature of zone 54 to between 800 degrees F. and 860 degrees F., depending on the gauge of the strip. The cooled zone functions to terminate alloying. Strip 52 then passes between heated gas jets 66, 68 which remove the spelter, exposing the iron-zinc alloy surfaces.

Claim 1, the sole independent claim, reads:

1. Continuous-strip method for producing coated steel strip comprising

(a) forming a molten galvanizing bath containing aluminum additions up to 0.30% by weight,

(b) introducing heated steel strip into the molten galvanizing [**3] bath, the strip entering the bath being at a temperature higher than the temperature of the molten spelter in the bath thereby adding heat to the bath,

(c) maintaining molten galvanizing spelter in the bath at a temperature of approximately 890 degrees F. to approximately 950 degrees F.,

(d) moving the heated strip through the bath toward an exit side of the bath,

(e) forming an iron-zinc alloy coating on the moving strip by contacting the moving strip with molten spelter at a temperature of approximately 890 degrees F. to approximately 950 degrees F.,

(f) delivering the strip from the exit side of the bath, the delivered strip having an inner iron-zinc alloy coating and an outer molten galvanizing spelter coating, and

(g) directing gas under pressure against at least one side of the coated steel strip upon delivery of the coated steel strip from the molten galvanizing bath to remove the molten galvanizing spelter coating from the

iron-zinc alloy coated steel strip on the one side.

All of the remaining method claims, and hence the two product-by-process claims, depend, directly or indirectly, from claim 1, adding various limitations thereto.

The Rejections

The examiner [**4] rejected the appealed claims, in various groups, on five different grounds. The board reversed one ground, leaving four which are as follows:

(1) Claims 1, 24-27, 29-46, and 52 because they fail to recite any cooling zone;

(2) Claims 2, 3, 6, 7, 9, 10, 12, 15, 16, 18-21, 23, and 51 because, though a cooling zone is specified, the location of the portion of the bath cooled is not specified;

(3) Claims 4, 5, 8, 11, 13, 14, 17, 22, 47, and 48 because, though a cooling zone and its location are specified, neither the temperature range in that zone nor its function is stated;

(4) Claims 51 and 52 because they are "improper" product-by-process claims.

The Examiner's Answer states that the foregoing rejections are under 35 USC 112 "for the reasons set forth in paragraph 11 of Paper No. 2." Continuing, it reads (all emphasis ours):

The examiner contends that what applicant refers to as his "invention covered by the appealed claims" * * * is not supported by the specification disclosure without the step of cooling a zone of the metal at the exit side of the bath. [*1232]

* * *

The examiner contends that what applicant refers to as the "best mode" of carrying out his [**5] invention is in fact the only mode supported by the specification disclosure.

* * *

Whether applicant's invention is considered to be mechanical or physical appears to be immaterial. The claims of mechanical as well as chemical cases must be "fairly supported by the original application".

Although the examiner failed to specify what paragraph of § 112 he was relying on - the better practice being to so specify in order to comply fully with the spirit of § 132 - it is clear that he was relying on § 112, paragraph one, which HN1 requires that claims be supported by an enabling disclosure. We have previously given extended consideration to similar ambiguous reliance on § 112 in In re Borkowski, 57 CCPA 946, 422 F.2d 904, 164 USPQ 642 (1970), and In re Moore, 58 CCPA 1042, 439 F.2d 1232, 169 USPQ 236 (1971). Reference to paragraph 11 of Paper No. 2, the examiner's final rejection, confirms that his rejection was, except for the product-by-process claims, based on insufficiency of the specification, for lack of enabling disclosure, to support the claims, which is a paragraph one rejection. Paragraph 11 further expounds on the rationale of the rejection. With emphasis added by us, [**6] it reads in pertinent part:

11. Claims 1-48, 51 and 52 are rejected under 35 U.S.C. 112 as failing to properly define the invention. Claims 1, 24-46 and 52 are based on an insufficient disclosure since applicant has disclosed that - cooling a portion of the molten spelter at the exit side of the bath to a temperature of approximately 800 degrees F. to approximately 860 degrees F - and - delivering the steel strip from the bath upon passage through the zone of cooled spelter - are essential steps in his inventive process. Claims 2, 3, 6, 7, 9, 10, 12, 15, 16, 18-21, 23 and 51 are based on an insufficient disclosure since applicant has disclosed that the zone of cooled spelter is located at the strip exit side of the bath. * * * Claims 4, 5, 8, 11, 13, 14, 17, 22, 47 and 48 are based on an insufficient disclosure since applicant has failed to specify the temperature of the zone of cooled spelter to be approximately 800 degrees F. to approximately 860 degrees F. or the function of the cooled spelter. * * * Claims 51 and 52 are improper product-by-process claims. Product-by-process claims are only permitted upon a showing by applicant that the product can only be described by referring [**7] to the process of making it. Note M.P.E.P. 706.03(e). It is noted that the resulting product was claimed in the parent application S.N. 375,264 without referring to the method of making the product.

In affirming these rejections, the board added nothing to the examiner's reasoning which requires notice. It simply agreed with him point by point, except as to the one ground it reversed, which we have omitted from paragraph 11, above.

OPINION

As the examiner noted in his Answer, the only mode of operation of appellant's process disclosed in his specification involves the employment of a cooling zone in the spelter bath at the point where the steel strip exits from the bath. Notwithstanding this fact, appellant asserts that his specification is enabling with regard to the formation of the desired alloy coating without the employment of a cooling zone, or without specially locating it.

To achieve the desired alloy coating, n1 appellant discloses two criteria. First, the iron must be alloyed with zinc out of contact with an oxidizing atmosphere. In other words, the alloying operation [*1233] must be performed wholly within the spelter bath before the strip enters the [**8] surrounding atmosphere. Second, the main body of the spelter bath is kept at a temperature higher than what is ordinarily considered optimum. Appellant has taught how to achieve both conditions by employing a cooling zone at the point where the strip leaves the bath. Without a cooling zone at the exit side, the unusually high bath temperature would cause alloying to continue when the strip leaves the bath (due to its high temperature) and result, for various reasons, in an inferior alloy coating. Appellant's specification states that the "strip * * * and bath * * * are raised in temperature above what is ordinarily considered optimum coating temperatures. This is practicable because of special cooling apparatus, specially located." (Emphasis ours.)

n1 Appellant describes his alloy coating as possessing "a uniform, smooth finish suitable for painting without bonderizing or other treatment and formable to the same extent as the base metal without cracking."

Although appellant now strenuously argues that the cooling bath is optional, his specification not only fails to support this contention, but leads us, as it did the examiner and board, to believe that both it and its [**9] location are essential. We therefore conclude that claims which fail to recite the use of a cooling zone, specially located, are not supported by an enabling disclosure. Rejections (1) and (2), supra, will therefore be sustained.

The board further affirmed the examiner's rejection of certain claims, which we have designated (3), because they fail to recite the temperature of the zone of cooled spelter or the function thereof. We will not sustain this rejection, which is the only rejection of this particular group of claims.

Appellant argues that the recitation of a specific temperature range would be unduly restrictive. The board and solicitor seem to agree on this point inasmuch as they merely insist that the function of the cooling zone be recited. However, we find that the cooling zone is taught to accomplish various functions, some of which are dependent upon numerous variables. Reading the claims, as they must be read, in the light of the specification, we think that the general function of the cooling zone is clear from the other recitations of the claims and that selection of the temperature of the zone would be within the ability of one of ordinary skill in the [**10] art attempting to follow the teaching of the specification. It is also apparent that the temperature of the cooling zone would have to be regulated to meet varying conditions, such as the temperature of the main body of the bath, the thickness of the strip, the speed of its movement through the bath, etc. For purposes of further discussion, we set forth claims 2 and 48:

2. The method claimed in claim 1 comprising subjecting a portion of the molten galvanizing spelter in the bath to heat exchange contact with a cooling fluid to cool said portion of the bath.

48. The method of claim 2 in which the cooled portion of the bath is located at the strip exit side of the bath and the steel strip is delivered from the molten galvanizing bath upon passage through the cooled portion, the strip as so delivered having thereon a weight of inner iron-zinc alloy coating of approximately 0.3 to approximately 0.7 ounce per square foot of strip and a smooth, even, non-gritty, outer molten galvanizing spelter coating. n2 [Emphasis ours.]

n2 The last-mentioned feature of this particular claim, namely, different surfaces on the inner and outer sides of the strip, is achieved by removing the spelter by gas blast from only one side as the strip emerges from

the cooling zone. Compare element (g) of claim 1, reproduced supra. Appellant calls this "differentially coated steel strip." [**11]

The emphasized words in claim 48 are present in each of the ten claims of the group under discussion.

We think it self-evident that the function of the cooling zone is simply to cool the strip. The reasons for cooling and the resultant advantages, which make clear what the proper degree of cooling will be in any given situation, are [*1234] explained in the specification. For example, it contains, inter alia, the following:

The cooled spelter zone is ordinarily held to a temperature around 840 degrees F. to 860 degrees F. with any variations below this range being dependent on the product. This zone is ordinarily not cooled below 800 degrees F. and a temperature around 820 degrees F. can be used when cooling requirements dictate, e.g. for the heavier gages. The remainder of bath 56 is maintained at a temperature around 900 degrees F. to 950 degrees F.

An important function of the galvanizing bath cooler is to cool the molten spelter applied to iron-zinc alloy coated strip and to cool the steel base metal. In this way, iron-zinc alloying is terminated before contact of the coated strip with ambient atmosphere.

* * *

The bath cooling apparatus serves other important [**12] functions such as reducing iron dissolution in the galvanizing spelter applied to the strip 52. The temperature of the galvanizing spelter on strip 52 upon exit from zone 54 is at or near the temperature of zone 54. If high temperature galvanizing spelter were present in zone 54, iron dissolution and dross formation would make it impossible to produce the smooth coat produced by the present invention. Without this cooling feature, a gritty, uneven, unacceptable surface would be formed and it would not be practicable to maintain the remainder of the bath at the temperature level required to produce the desired alloy.

We are therefore of the opinion that the specification is enabling with respect to the claims of this group. The PTO has not insisted that a temperature range be set forth, and we feel that a statement of function would be superfluous. HN2 The language employed in a claim must always be analyzed in light of the specification, which here adequately teaches the function of the zone of cooled spelter. See In re Sarett, 51 CCPA 1180, 327 F.2d 1005, 140 USPQ 474 (1964); In re Corr, 52 CCPA 1505, 347 F.2d 578, 146 USPQ 69 (1965); In re Honn, 53 CCPA 1469, 364 F.2d 454, 150 [**13] USPQ 652 (1966).

In view of our affirmance of the rejection of claims 51 and 52 on grounds (1) and (2), ground of rejection (4), supra, which involves only these two claims, need not be, and is not, reached. n3

n3 We have noted the solicitor's statement that should we reach this rejection, he suggests a remand in view of a change made in M.P.E.P. 706.03(e) and our decision in In re Hughes, 496 F.2d 1216, 182 USPQ 106 (CCPA 1974). These go only to the question of whether the claims are "improper."

Accordingly, the decision of the board as to claims 1-3, 6, 7, 9, 10, 12, 15, 16, 18-21, 23-27, 29-46, 51, and 52 is affirmed and its decision as to claims 4, 5, 8, 11, 13, 14, 17, 22, 47, and 48 is reversed.

MODIFIED

CONCURBY: BALDWIN

CONCUR: BALDWIN, Judge, concurring.

Background

I completely agree with the majority opinion in this case, as far as it goes. I find myself compelled to express my views by way of this concurring opinion because the majority does not go far enough.

This appeal has been before us for quite some time. As the majority states, our original opinion was handed down on March 13, 1975. We granted appellant's Petition for Rehearing basically because [**14] of our

uncertainty of the appropriate paragraph of 35 USC 112 employed by the PTO as a basis for its rejections. I have maintained, from the outset, that a complete disposition of the present appeal required an analysis of both the first and second paragraphs of § 112. The majority has elected to discuss only the first paragraph; I shall deal with the second.

I have decided to express my views by way of this concurring opinion for another reason. It would seem that my [*1235] understanding of the meaning of the second paragraph of § 112 is not shared by my brothers of this court. Through the years, I have played an active role in developing our case law in this vital area. Beginning in 1970, we departed from a vast line of authority which permitted the PTO to reject claims under the second paragraph of § 112 for "undue breadth." Up to that time, examiners quite frequently determined what they felt the invention was and rejected all claims which were broader than their conception of the invention, using the second paragraph of § 112 as the statutory basis. Most often, the examiner's conception of the invention was derived from a reading of an applicant's specification. [**15]

The present appeal is not one of these cases. As the following opinion will show, this court is improperly confusing "undue breadth" with the situation presented in the instant case, wherein certain claims do not recite that which applicant, in his own words, regards as his invention.

The Rejections

The majority characterizes the rejection made by the examiner and affirmed by the board to be solely founded upon the first paragraph of § 112. However, as the majority recognizes, no specific paragraph of § 112 has been referred to by either the examiner or board. Thus, we are forced to speculate as to the specific rejection(s) involved herein.

The board affirmed the examiner's rejections which were recited in paragraph 11 of Paper No. 2 of the final rejection. The majority has quoted paragraph 11 and repetition of it now would serve no purpose. The board then continued:

Claims 1, 24 to 46 and 52 were rejected under 35 U.S.C. 112 as failing to recite - cooling a portion of the molten spelter at the exit side of the bath to a temperature of approximately 800 degrees F. to approximately 860 degrees F - and - delivery of the steel strip from the bath upon passage through [**16] the zone of cooled spelter. We will sustain this rejection because we are convinced from the disclosure in the specification that appellant clearly regarded these steps as essential steps in his inventive process. These steps are not recited in these claims.

* * *

Claims 2, 3, 6, 7, 9, 10, 12, 15, 16, 18 to 21, 23 and 51 were rejected under 35 U.S.C. 112 as failing to recite the location of the zone of cooled spelter at the strip exit side of the batch. We agree with the rejection.

* * *

From the disclosure in appellant's specification * * * there is a very strong inference that if the cooling zone were not specially located at the exit side of the metal coating bath, it would not render practicable the employment of bath temperatures above what are ordinarily considered optimum coating temperatures. Under these circumstances, since the claims under consideration do not recite the special location of the cooling zone, and the specification clearly teaches that the location is specific, the scope of enablement is not commensurate with the scope of protection sought. We will sustain the rejection.

Analysis of the language used by the examiner and board indicates that [**17] both the first and second paragraphs of § 112 were employed in rejecting appellant's claims. The examiner seemed more interested in § 112, first paragraph, when he stated that "[claims] 1, 24-46 and 52 are based on an insufficient disclosure since applicant has disclosed that * * *." n1

n1 It is interesting to note however that the examiner commenced his rejection with the following sentence:

Claims 1-48, 51 and 52 are rejected under 35 U.S.C. 112 as failing to properly define the invention.

This is clearly material to a second paragraph rejection. [*1236]

definiteness of claim language. If the scope of subject matter embraced by a claim is clear, and if the applicant has not otherwise indicated that he intends the claim to be of a different scope, [emphasis added] then the claim does particularly point out [**21] and distinctly claim the subject matter which the applicant regards as his invention. That is to say, if the "enabling" disclosure of a specification is not commensurate in scope with the subject matter encompassed by a claim, that fact does not render the claim imprecise or indefinite or otherwise not in compliance with the second paragraph of § 112; rather, the claim is based on an insufficient disclosure (§ 112, first paragraph) and should be rejected on that ground. See In re Fuetterer, 50 CCPA 1453, 319 F.2d 259, 138 USPQ 217 (1963); In re Kamal, 55 CCPA 1409, 398 F.2d 867, 158 USPQ 320 (1968); and In re Wakefield (PA 8192), decided concurrently herewith.Thus, just as a claim which is of such breadth that it reads on subject matter disclosed in the prior art is rejected under § 102 rather than under the second paragraph of § 112, a claim which is of such breadth that it reads on subject matter as to which the specification is not "enabling" should be rejected under the first paragraph of § 112 rather than the second. We do not intend hereby to suggest that rejections under § 112 must be labeled "first paragraph" or "second paragraph." What we do suggest is that it should [**22] be made clear exactly which of the several requirements of § 112 are thought not to have been met. Is the claim unclear or is the specification's disclosure inadequate to support it? [Footnotes deleted.]

A close examination of Borkowski indicates that appellant's protestations are not well founded. Borkowski involved a rejection of certain claims (claims 7-10) under 35 USC 112 because they "are unduly broad and indefinite in the recitation of the 'hydrocarbon reactant.'" The examiner reasoned as follows:

This term ["hydrocarbon"] encompasses an almost limitless number of compounds, and, hence, is not adequately supported by the somewhat limited disclosure. The salient absence of a representative example for the various types of hydrocarbons alleged to be suitable for use in the instant process further [renders] the support for the breadth of the claims on appeal inadequate. [Emphasis added.]

Thus, Borkowski was a case dealing with the breadth of claims, not whether an appellant was claiming what he regarded as his invention. The examiner's only criticism was that the specification did not support a term as broad as "hydrocarbon." Certainly the court was correct [**23] in its decision that the claims should have been rejected under the first paragraph of § 112 as being based on a specification which was not enabling, rather than on the second paragraph.

In reaching the conclusion that certain of appellant's claims fail to satisfy 35 USC 112, second paragraph, I am not resurrecting the old rejection of claims being too broad. n3

I am following Borkowski and Moore in that I now reaffirm the conviction that a claim is considered to particularly point out and distinctly claim the subject matter which the appellant regards as his invention unless appellant has otherwise indicated that he intends the claims to be of a different scope. As can be seen from the passages quoted from appellant's specification, supra, appellant regards his invention to be [*1238] practicable only by inclusion of a cooling zone specially located.

n3 See, for example, In re Garvin, 55 CCPA 995, 392 F.2d 286, 157 USPQ 190 (1968), and the cases cited therein.

My position in this case does not stand as an isolated example of the application of § 112, second paragraph, as a basis for the rejection of claims as failing to particularly point out and distinctly [**24] claim the subject matter which the applicant regards as his invention. In In re Prater, 56 CCPA 1381, 415 F.2d 1393, 162 USPQ 541 (1969) we affirmed the rejection of a claim which admittedly covered a purely mental process or a mental process coupled with pencil and paper. The Prater specification described the invention in terms of a machine or apparatus for carrying out the claimed process and, in fact, appellant's position on appeal was that the claims were not intended to embrace a purely mental process. The court thus concluded that

[inasmuch] as claim 9, thus interpreted, reads on subject matter for which appellants do not seek coverage, and therefore tacitly admit to be beyond that which "applicant regards as his invention," we feel that the claim fails to comply with 35 USC 112 [second paragraph] which requires that "[the] specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." [Emphasis in original.]

I can find no substantive difference between Prater and the case we are now called upon to decide. In

Prater, the court found in appellants' brief a [**25] statement of what appellants felt was their invention. This differed from the scope of the appealed process claim and the conclusion was reached that a rejection based upon the second paragraph of § 112 was proper. In the present case, a similar conclusion is reached based upon statements made in appellant's specification. There is nothing magical about where such information is derived.

I also note that I do not stand alone in my interpretation of the second paragraph of § 112. Of particular interest is Henry J. Kaiser Co. v. McLouth Steel Corp., 257 F.Supp. 372, 150 USPQ 239 (E.D. Mich. 1966), aff'd sub nom. Kaiser Industries Corp. v. McLouth Steel Corp., 400 F.2d 36, 158 USPQ 565 (6th Cir. 1968), cert. denied, 393 U.S. 1119, 160 USPQ 832 (1969) (hereafter McLouth).

The specification of the patent involved in the McLouth litigation described a process whereby steel was refined by using a high speed jet of pure oxygen directed vertically downwards onto a bath of molten metal, through an early-formed slag layer, in a manner so as to avoid deep penetration of the metal bath by the oxygen. The patent claims did not mention the avoidance of deep penetration. n4

n4 The claims read as follows:

1. Method of refining molten impure iron in the presence of a slag in a vessel having a refractory lining by blowing with oxygen, which comprises discharging a stream of oxygen vertically downwardly through the slag layer onto and below the surface of the bath at the central portion thereof, to an extent to avoid material agitation of the bath by the oxygen stream, the contact of the oxygen with the bath resulting in reaction of the oxygen with a portion of the iron and with the oxidizable impurities of the bath in a localized reaction zone spaced a substantial distance from the refractory lining, the reactions in said zone resulting in refining of the iron and gas evolution and in the production of high temperature in the reaction zone away from the refractory lining, said reaction producing a circulatory movement in the molten metal, which circulatory movement brings those portions of the molten metal bath which are remote from the reaction zone into the reaction zone whereby those portions are subjected to said reaction with minimum injury to the refractory lining.

2. The gaseous oxygen process set forth in claim 1 in which the oxygen is blown into said vessel under pressure in a range between about five and about twenty-five atmospheres above normal atmospheric pressure. [**26]

The district court was faced with the issue of validity of the patent in suit. It decided that the patent was invalid inter alia because the claims did not particularly and distinctly claim the invention [*1239] described in the specification. This finding was specifically affirmed by the Sixth Circuit Court of Appeals. See 400 F.2d 50, 158 USPQ 579.

The district court noted at 158 F.Supp. 425, 150 USPQ 281, that:

The specification of the patent in suit teaches the avoidance of deep penetration as an essential characteristic of the process of the patent. * * * Further, plaintiffs in this litigation have repeatedly contended that the "new mental concept" that differentiates the invention of the patentees from the prior art Schwarz and Miles patents, and also the teachings of Dr. Durrer and Dr. Hellbruegge, was a reduction in impact pressure so as to avoid the deep penetration suggested by the prior teachings.

The court then expounded upon its understanding of the law in this area and concluded:

For a valid patent, Section 112 requires a statement of claim or claims which particularly point out and distinctly claim the subject matter which the applicants regard as [**27] their invention. In the instant case, the avoidance of deep penetration is clearly the subject matter which applicants regarded as their invention, and yet the concept of the avoidance of deep penetration simply cannot be read into the claims of the patent in suit. The language of the claims admittedly does not refer expressly to the avoidance of deep penetration of the bath by the jet * * *, nor can any language of the claims be construed to contain such a meaning.

An attempt was made to relitigate the same patent in the Third Circuit. Kaiser Industries Corp. v. Jones & Laughlin Steel Corp., 181 USPQ 193 (W.D. Pa. 1974), rev'd, 515 F.2d 964, 185 USPQ 343 (3rd Cir. 1975). The district court refused to apply the Supreme Court's decision in Blonder - Tongue n5 and thus refused to rule that the plaintiff was collaterally estopped from asserting that its patent was valid. In reversing, the Third

Circuit Court of Appeals stated at 515 F.2d 982, 185 USPQ 358:

n5 402 U.S. 313, 169 USPQ 513 (1971).

However, for purposes of collateral estoppel, we must accept the McLouth invalidation of the Suess patent based on the inadequacy of the claims under section 112, unless the Michigan [**28] court did not comprehend the case or, specifically, that issue. We do not find the Michigan decision so infirm. [Footnote 83a deleted.]

I also feel compelled to discuss our prior decision, In re Conley, 490 F.2d 972, 180 USPQ 454 (CCPA 1974). Conley dealt with a method of improving the handleability of a satin white-kaolinite paper coating pigment. Certain claims were rejected under the second paragraph of § 112 for their failure to recite operative proportions of the various ingredients. The board misread appellants' specification as allegedly describing the object of their invention as the production of an improved paper coating composition. The board noted that pigment concentrations outside certain limits fail to possess these improved characteristics and were thus indefinite.

We correctly reversed the board in Conley, citing In re Borkowski, supra, and related cases for the proposition that "[if] the scope of subject matter embraced by a claim is clear, and if the applicant has not otherwise indicated that he intends the claim to be of a different scope, then the claim does particularly point out and distinctly claim the subject matter which the applicant regards [**29] as his invention." Unfortunately, however, Conley contains certain dicta which is ambiguous and may, at first blush, seem contrary to my position in this case.

Although the board only affirmed the examiner's rejection under the second paragraph of § 112 for indefiniteness of claim language, we decided, in Conley, to discuss rejections based upon whether an applicant was claiming the subject matter which he regarded as his invention. [*1240] See 490 F.2d at 976, 180 USPQ at 456. The language we employed is worth quoting:

Occasionally the first sentence of the second paragraph of § 112 has been relied upon as a basis for rejection of a claim, not because of "indefiniteness" of the claim language but because the language used did not particularly point out and distinctly claim the subject matter which the applicant regards as his invention. This portion of the statutory language has been relied upon in cases where some material submitted by applicant, other than his specification, shows that a claim does not correspond in scope with what he regards as his invention. In re Prater, 56 CCPA 1381, 415 F.2d 1393, 162 USPQ 541 (1969); In re Cormany, 476 F.2d 998, 177 USPQ 450 [**30] (CCPA 1973). There has been no reliance here on anything other than appellants' specification to suggest this as a basis for the second paragraph rejection made. [Emphasis in original. Footnote 3 deleted.]

The difficulty arises from the emphasized portion of the quoted language which seems to lead one to conclude that the specification cannot form the basis for the rejection of a claim under the second paragraph of § 112 for not particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Such a conclusion based upon Conley would be incorrect. The emphasized language is allegedly supported by the citation of two of our prior decisions: In re Prater, supra, and In re Cormany, 476 F.2d 998, 177 USPQ 450 (CCPA 1973). Cormany cited Prater and concluded that:

[Claim] 12 and the claims dependant thereon include within their scope the use in the composition of an amount of a nitroalkane as small as 0.5 weight percent. Appellants' affidavits make clear that this is not an "amount * * * large enough to stabilize" under the test conditions prescribed in these claims and that they do not regard it as within their invention. [**31] These claims, therefore, do not particularly point out and distinctly claim what appellants regard as their invention and do not comply with § 112, second paragraph.

Although Prater did not rely upon statements in appellants' specification for our affirmance of the second paragraph rejection, there was no indication in Prater that the specification could not be used in formulating such a rejection. n6

n6 I note with interest the following passage from Pat. L. Persp. § A-5[2][b]-23 (1974 Dev.):

It is well established that the Section 112 P2 requirement that the claims must particularly point out and distinctly claim the subject matter which the applicant regards as his invention is a requirement for "precision" and "definiteness." If the scope of the subject matter embraced by a claim is clear and if the applicant has not otherwise indicated that he intends the claim to be of a different scope, Section 112 P2 is satisfied. In In re Conley, the CCPA has now further honed one of the two prongs of this test by holding that the evidence relied on by the examiner to demonstrate that the applicant has not claimed what he regards as his invention must be found outside the specification.

The court in Conley is correct in noting that in the cases where the issue has thus far arisen, the evidence relied on was outside the specification. Those cases did not, however, indicate that the proofs must be limited to such outside evidence. And, needless to say, one must search in vain in the statute for any support for this judicial gloss. [Footnotes 49, 50 and 51 deleted.] [**32]

If Conley is the law in this area, the majority could not affirm a paragraph two rejection in the present case. I am of the view that we went astray in Conley and I am pleased that this appeal has presented a factual environment conducive to a discussion of this issue.

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Effects of Strip Intercropping and No-Tillage on Some Pests and Beneficial Invertebrates of Corn in Ohio

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ABSTRACT We tested two agronomic practices that are likely to increase plant and structural diversity, no-tillage and strip intercropping, for effects on corn invertebrate fauna. Some of the most common herbivores and natural enemies were sampled by direct counts and damage estimation from 1988 through 1990 on monoculture corn and strips of corn alternated with soybean, under no-tillage and conventional tillage. Among soil pests, cutworms (mostly the black cutworm, *Agrotis ipsilon* (Hufnagel)); armyworm, *Pseudaletia unipuncta* (Haworth); and slugs (Gastropoda) were more abundant in no-tillage plots, although only slugs caused severe damage. The western corn rootworm, *Diabrotica virgifera virgifera* LeConte, and the European corn borer, *Ostrinia nubilalis* (Hübner), were generally more abundant in conventional tillage plots. Despite crop rotation, the strip-intercropping system (four rows of each crop) was less effective in reducing western corn rootworm infestation, especially in conventional tillage plots. In 1990 only, ladybugs (mostly *Coleomegilla maculata* (DeGeer)) were more abundant in conventional tillage plots, whereas tarnished plant bugs, *Lygus lineolaris* (Palisot de Beauvois), were more abundant in no-tillage plots. Japanese beetle, *Popillia japonica* Newman; stink bugs, *Acrosternum hilare* (Say) and *Euschistus servus* (Say); and spiders (Aranea) were not significantly affected by treatments.

KEY WORDS Insecta, no-tillage, intercropping, corn

CONSERVATION-TILLAGE practices (reduced tillage or no-tillage) are being used increasingly in the United States, with the main objectives of erosion control and energy savings (Phillips et al. 1980). Lessiter (1983) estimated that about 35% of all corn and soybean planted in the United States is now grown under conservation tillage. Intercropping and other multiple-cropping practices are primarily restricted to the tropics, because of agronomic, environmental, and social advantages. However, multiple-cropping systems are becoming common in the southeast United States, mostly as double cropping of winter wheat and summer soybean (Francis 1989). In the Midwest, the combination of soybean and corn in strip intercropping has been tried as an economic alternative for monocultures (Reynolds 1986).

Conservation-tillage practices result in higher structural diversity (because of greater retention of residue on the soil surface) and frequently generate greater weed populations (higher plant species diversity) because of inadequate weed control (Kostiken & McWhorter 1986). Conservation-tillage practices are also likely to affect the crop microclimate, plant physiology, plant architecture, and plant size (Phillips et al. 1980, Stinner & House 1990). In multiple-cropping systems, apart from the evident increase in plant species diversity, there are changes in patch size (area of a stand of plants), plant density, and plant quality (Francis 1989). Consequently, conservation-tillage and multiple-cropping practices influence resource concentration and therefore, may affect density of pests and other organisms (Kareiva 1983). There is little information about the effects of multiple cropping on corn insects, but reduced-tillage practices are expected to increase the incidence of some pests such as black cutworm, *Agrotis ipsilon* (Hufnagel); armyworm, *Pseudaletia unipuncta* (Haworth); and slugs. However, for other important pests such as corn rootworms, *Diabrotica* spp., and the European corn borer, *Ostrinia nubilalis* (Hübner), responses to tillage treatments have been inconsistent (Musick 1987, Stinner & House 1990). The objective of this study was to quantify populations of the most common insects and other invertebrates that occur on corn in response to no-tillage and strip-intercropping treatments, as these agronomic practices have the potential to be implemented on a large scale.

Materials and Methods

Agronomic Practices. The study was conducted from 1988 through 1990 at the Ohio Agricultural Research and Development Center, Wooster, Ohio. The experiment site had been planted with no-tillage corn for 2 yr before this study, and it was surrounded by farmland in a radius of ≈0.5 km. Twenty-four plots (18.3 by 15.8 m each) were arranged in a factorial design with four blocks. The factors were two tillage systems (no-tillage and con-

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ventional tillage) and three cropping systems (corn monoculture, soybean monoculture, corn and soybean intercropped). Plots under conventional tillage were plowed with a mold-board plow and disked in the spring just before planting; in the no-tillage plots planting was done directly into the stubble. The intercropping system consisted of three strips of each crop per plot, each strip with four rows. The number of rows and row width were the same for all plots (24 and 76.2 cm, respectively). We used corn variety 'Pioneer 3780' in 1988, replaced by variety 'Pioneer 3552' in 1989 and 1990 because the first variety was no longer available. Corn was planted at a rate of 66,700 seeds/ha in all 3 yr. Soybean variety 'Asgrow 3127' was planted at a density of 562,000 seeds/ha in all three years. The planting dates were 5 May, 17 May, and 14 May for the three consecutive years. Corn and soybean plots and strips were rotated in 1989 and 1990.

In 1988 and 1990, areas of corn were sprayed with recommended preemergence herbicides (cyanazine 2.2 kg [AI]/ha, alachlor 2.2 kg [AI]/ha, and paraquat 0.56 kg [AI]/ha). In areas with soybean, cyanazine was substituted for linuron (0.56 kg [AI]/ha). In 1989, rains prevented herbicide treatment until plants had germinated, so plots were sprayed with paraquat (1.1 kg [AI]/ha) after the crops were protected by strips of metallic foil. After the initial herbicide treatment, weeds in all plots were controlled by hand weeding, except for one application of glyphosate (33% solution) 2 wk after planting in 1988 on sites heavily infested by Canada thistle, *Cirsium arvense* (L.) Scop. Hand weeding was only used to maintain the weed canopy below the crops' level, reducing competition for light. The vegetation outside the plots was periodically controlled by disking the alleys between plots (3–4 m wide) and mowing the grassy boundary that surrounded the experimental area. Six weeks after planting, all plots were fertilized with P and K (0–26–26, 58.0 kg/ha), and corn plots and strips received N (117.0 kg/ha). Because of low rainfall during the early season of 1988, plots were irrigated at two 24-h periods 1 wk apart in late June.

Average plant size and yield were calculated using corn plants collected to sample the second generation of the European corn borer (see below). Corn ears were shelled and weighed, and one 100-g grain sample per plot was dried at 60°C until constant weight to determine moisture content. Grain weight (grams per 10 plants) was corrected to 15.5% moisture (a standard value for corn storage), and together with the average number of plants per row allowed estimation of yield (kilograms per hectare).

Sampling. All arthropods (except for second generation of European corn borer) and damaged plants were counted on 20 consecutive plants per row at two randomly selected sites per plot. Each plant was initially scanned from top to bottom, followed by a quick examination of leaves, whorl, tassel, and ear. The average time needed to sample one plant depended on development stage, but varied from ≈5 s for early vegetative stages to ≈15 s during reproductive stages. Flying insects were not counted, and when the plants were too tall, only leaves up to ≈1.8 m were examined. Therefore, decreased accuracy can be expected when western corn rootworm was abundant because this insect readily takes flight when disturbed, or for late season samples, when much of a plant was not examined. However, because there was no indication of a systematic bias that reduced sampling precision, visual counts were considered reliable to detect treatment differences. Within each plot, the first four rows on each side and ≈2 m at the beginning of each row were not sampled to reduce edge effect.

During early season (from plant emergence to late June), damage caused by cutworms (mostly black cutworm) was estimated every 2 wk by the number of plants cut or damaged at their base. Damage caused by armyworms was assessed by counting the number of plants with characteristic injury on leaves and whorls. Stalk borers, *Papaipema nebris* (Guenée), were present in all 3 yr but at insignificant levels, and were not included in the sampling. In 1988, ladybugs, mostly *Coleomegilla maculata* (DeGeer); Japanese beetles, *Popillia japonica* Newman; stink bugs, *Acrosternum hilare* (Say) and *Euschistus servus* (Say); and tarnished plant bugs, *Lygus lineolaris* (Palisot de Beauvois), were sampled weekly from 30 June to 1 September. Spiders also were sampled in 1989 and 1990, and sampling was conducted weekly from 5 July to 1 September in both years. Japanese beetles, plant bugs, and stink bugs are general feeders and are not considered to be pests of corn, but they were sampled because their abundance could provide evidence of treatment effects. Flea beetles (mostly the corn flea beetle, *Chaetocnema pulicaria* Melsheimer) and anthocorid bugs, *Orius* spp., were common, but the visual samples were not considered suitable to estimate densities of such small and highly mobile insects. Density of the first generation of European corn borer was estimated by counting the number of plants with evidence of feeding and fresh frass in the whorl. This method was considered a reliable sampling method, as dissection of a 20-plant sample with that combination of signs revealed European corn borer larvae in all plants. Beginning on the second week of July in all 3 yr, adult western corn rootworms, *Diabrotica virgifera virgifera* LeConte, were sampled weekly for 5 wk. Densities of the northern corn rootworm, *D. barberi* Smith & Lawrence, and the southern corn rootworm, *D. undecimpunctata howardi* Barber, were low in all 3 yr and are not reported.

In late July of each year, five randomly chosen corn plants per plot had their root systems evaluated for rootworm damage using Hills & Peters (1971) damage scale. Adult corn rootworm counts and root damage evaluation in 1989 suggested that cropping system affected rootworm oviposition (see

Table 1. ANOVA results for armyworms, cutworms, and slugs in 1988 and 1989 (there were no measurable infestations in 1990)

Pest	Tillage	1988			1989		
		$\bar{x} \pm$ SD	F	P	$\bar{x} \pm$ SD	F	P
Armyworms	None	3.5 ± 2.3	17.85	0.05	1.6 ± 1.2	7.22	0.02
	Conventional	1.0 ± 0.7			0.4 ± 0.8		
Cutworms	None	0.9 ± 1.4	5.24	0.05	—	—	—
	Conventional	0.1 ± 0.2					
Slugs	None	—	—	—	1.5 ± 0.7	6.73	0.04
	Conventional				0.5 ± 0.5		

Means (number of damaged plants per 20 plants for armyworms and cutworms, and slugs per row-meter), standard deviations, and F values are for the tillage factor. df = 1, 9

...ie needed to sample one plant ...pment stage, but varied from ...tative stages to ≈15 s during ... Flying insects were not count... ...lants were too tall, only leaves ...amined. Therefore, decreased ...ected when western corn root... ...because this insect readily takes ...ed, or for late season samples, ...it was not examined. However, ... no indication of a systematic ...mpling precision, visual counts ...liable to detect treatment dif... ...ch plot, the first four rows on ... at the beginning of each row ...o reduce edge effect.

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For assessing damage of second-generation European corn borer, corn plants were collected during late season (15, 7, and 20 September for the 3 yr consecutively) and dissected. Twenty plants per plot were examined in 1988, and 10 plants per plot were examined in 1989 and 1990. The results were expressed in number of plants infested per 10 plants, number of larvae per 10 plants, and number of larvae per 10 infested plants.

Because plants were significantly damaged by slugs in the early season of 1989, plots were evaluated using a defoliation scale from zero to three: 0, little damage, up to 5% defoliation; 1, visible damage, 5–10% defoliation; 2, significant damage, 10–50% defoliation; and 3, severe damage, >50% defoliation. Slugs were counted at three sites per plot during the night after the damage evaluation (17 June), and densities were expressed in numbers per row-meter.

Statistical Analysis. Analyses of variance (ANOVA) were performed on the total numbers of damaged plants and on species or other taxa collected per plot over the season. Examination of the data indicated different requirements to comply with the assumptions of the ANOVA. Therefore, before analyses the numbers of western corn rootworm adults were transformed into $\log(x + 1)$, and numbers of the remaining arthropods, slugs, rootworm eggs, damaged plants, and plants per meter were transformed into $\sqrt{x \pm 0.5}$. Results of yield and plant size were analyzed using untransformed values. Because this study focused on corn fauna only, analyses were performed as a 2 × 2 factorial design with blocks (monoculture and intercropping, conventional tillage and no-tillage). When the interaction effect (tillage × cropping system) was significant, means for each treatment were separated by the least significant difference (LSD) test. The results of root and plant damage were analyzed by Friedman's two-way ANOVA test, and means were separated by the corresponding multiple-comparison procedure (Daniel 1978). Association between plant parameters and densities of western corn rootworm and European corn borer (the most abundant insects) were investigated by correlation analyses.

Results

The number of plants damaged by cutworms and armyworms was significantly higher in no-tillage than in conventional tillage plots in 1988 (Table 1). The damage caused by armyworms was heaviest from 14 June to 30 June, whereas damage from cutworms was observed on 14 June only. In 1989, there was no noticeable infestation of cutworms, and armyworm damage was visible on only one sampling date (19 June), with no-tillage treatments showing significantly higher damage than conventional tillage (Table 1). Densities of slugs were significantly higher in the no-tillage treatment compared with conventional tillage in 1989 (Table 1). This finding was also supported by the estimation of defoliation (although visual evaluation also reflected less important damage from other pests, such as armyworms). The defoliation score ($\bar{x} \pm$ SE) for corn plants in no-tillage plots was 2.9 ± 0.4, significantly higher ($\chi^2 = 7.91$, df = 3, $P < 0.05$, Friedman's test; $\chi^2_{0.05} = 7.81$) than for corn in conventional tillage plots (2.0 ± 1.4). There were no substantial infestations of cutworms, armyworms, or slugs during 1990.

There were about twice as many adult corn rootworms in conventional tillage plots as in no-tillage plots in 1988 (Fig. 1) ($F = 14.31$; df = 1, 9; $P = 0.005$). There was an overall reduction in western corn rootworm densities in 1989, and significantly higher numbers of beetles were found on intercropped corn (Fig. 1) ($F = 39.85$; df = 1, 9; $P = 0.001$). However, there was a significant interaction in 1990 between main effects ($F = 28.62$; df = 1, 9; $P = 0.0007$), and means separated by the LSD test showed that the intercropped–conventional tillage treatment had a significantly higher number

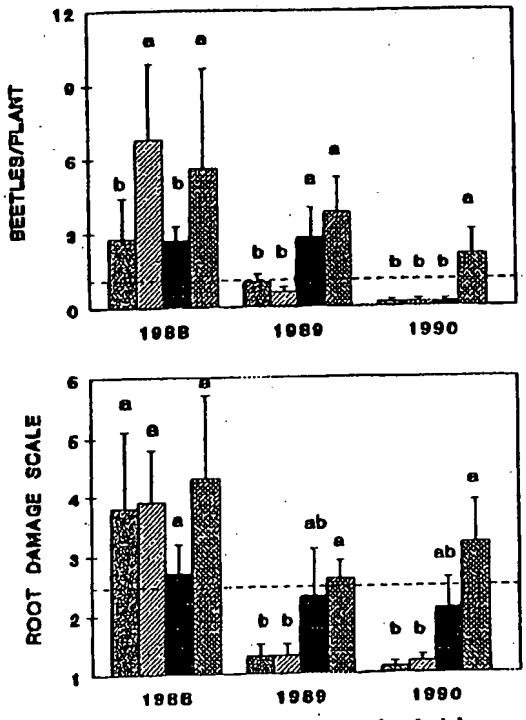

Fig. 1. Western corn rootworm: results of adult counts during highest infestation (1988: 26 July; 1989 and 1990: 3 August) and root damage evaluations. ▨, monoculture, no-tillage; ▨, monoculture, conventional tillage; ■, intercropping, no-tillage; and ▩, intercropping, conventional tillage. The dotted lines indicate the economic thresholds, and vertical lines are standard deviations.

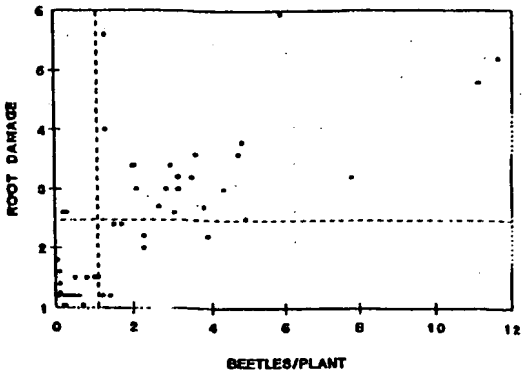

Fig. 2. Three year's results of adult counts and root damage evaluation of western corn rootworm for each corn plot. The dotted lines represent the economic thresholds.

of beetles than the other three treatments (Fig. 1). Root damage in intercropped–conventional tillage plots was significantly higher than in monoculture plots in 1989 ($\chi^2 = 8.82$, df = 3, $P < 0.05$, Friedman's test; $\chi^2_{0.05} = 7.81$) (Fig. 1). The results from 1990 were similar, with significantly higher damage in intercropped–conventional tillage plots ($\chi^2 = 14.80$, df = 3, $P < 0.01$, Friedman's test; $\chi^2_{0.99} = 11.30$). Root damage and adult counts were significantly correlated during all 3 yr (1988: $r = 0.520$; 1989: $r = 0.921$; 1990: $r = 0.720$; $P < 0.05$ after the Bonferroni adjustment; $n = 16$ for each year). Pooled data for all plots during 3 yr indicated that 79.2% of the results for root damage evaluation and adult counts coincided in determining infestation above or below economic levels (Fig. 2), a highly significant result according to a chi-square test of independence ($\chi^2 = 15.63$, df = 1, $P < 0.005$; $\chi^2_{0.995} = 7.88$). The egg counts in spring 1990 revealed more rootworm eggs in soil collected from areas planted with corn in the year before, with intercropped corn showing higher numbers (10.5 ± 8.4 eggs/liter of soil) than monoculture corn (4.0 ± 3.0), although not statistically significant ($F = 3.67$; df = 1, 9; $P = 0.08$). There were 2.5 ± 3.2 rootworm eggs/liter in soil collected from areas planted with intercropped soybean in the year before, significantly higher ($F = 4.78$; df = 1, 9; $P = 0.05$) than the 0.1 ± 0.3 eggs found in monoculture soybean. There was no significant tillage effect or interaction.

Densities of European corn borer were low in the first generation during 1988; however, ≈29% of the corn plants were infested by the second generation. Significantly more ($F = 10.14$; df = 1, 9; $P = 0.01$) plants were infested in conventional tillage plots (3.7 ± 0.6 infested plants per 10 plants) than in no-tillage plots (2.2 ± 0.9). The number of larvae per 10 plants was also higher in conventional tillage plots (Table 2). The highest density of the first generation of European corn borer occurred in 1989, with significant difference between tillage treatments (Table 2). The tillage effect was more apparent on earlier counts (Fig. 3). Sixty-six percent of plants were infested with second-generation European corn borer larvae, but with no significant treatment effects. In 1990, higher densities of first-generation borers occurred in conventional tillage when compared with no-tillage. However, the number of second-generation larvae per 10 plants was significantly higher only for the conventional tillage–monoculture treatment (Table 2), and the overall infestation rate was 69%. There were no significant differences for the number of larvae per infested plant in any year, with 1.5 ± 0.3 larvae per plant in 1988, increasing to 2.0 ± 0.6 in 1989 and 2.0 ± 0.4 in 1990. Taller plants were infested at higher levels in 1988 and 1990 (Fig. 4). Plants in the range 150–200 cm were infested at levels of 21 and 50% in 1988 and 1990, respectively. For the 200–250 cm size range, infestation levels were 40 and 76.6% in 1988 and 1990, respectively. These results were statistically different when analyzed by a chi-square test (1988: $\chi^2 = 4.59$, $P < 0.05$, df = 1, $\chi^2_{0.05} = 3.84$; 1990: $\chi^2 = 10.40$, $P < 0.01$, df = 1, $\chi^2_{0.99} = 6.63$). However, correlation analyses be-

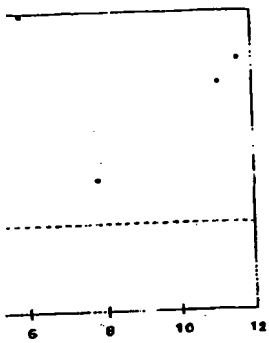

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Table 2. ANOVA results for the numbers of European corn borer larvae per 10 plants

Year	Tillage	First generation			Crop	Second generation		
		$\bar{x} \pm SD$	F	P		$\bar{x} \pm SD$	F	P
1988	Conventional	—	—	—		5.9 ± 1.8	7.48	0.02
	None					3.3 ± 1.8		
1989	Conventional	4.5 ± 1.6	5.11	0.05		13.6 ± 6.7	0.12	0.7
	None	2.6 ± 1.1				13.2 ± 5.0		
1990	Conventional	1.1 ± 0.3	16.22	0.003	Monoculture	21.7 ± 4.8	4.61	0.04
	None	0.3 ± 0.3			Intercropping	11.4 ± 3.8		

Means, standard deviations, and F values are for the tillage factor, except for the second generation in 1990, where F reflects interaction effect and means were separated by the Least Significant Difference test. df = 1, 9.

tween numbers of European corn borer per 10 plants and plant height indicated significant differences for 1990 only ($r = 0.598$, $P = 0.01$, $n = 16$).

Japanese beetles, stink bugs, and spiders were not affected by treatments in any year. Ladybugs and plant bugs responded to treatments in 1990 only; there were 5.5 ± 2.0 ladybugs per 20 plants in conventional tillage plots, a significantly higher value ($F = 5.18$; df = 1, 9; $P = 0.05$) than in no-tillage plots (3.8 ± 1.4). Plant bugs were affected by tillage and cropping system (tillage: $F = 50.05$; df = 1, 9; $P = 0.002$; and cropping system: $F = 9.34$; df = 1, 9; $P = 0.01$), with 5.4 ± 1.6 and 1.5 ± 0.7 plant bugs per 20 plants in no-tillage and conventional tillage plots respectively, and 4.4 ± 2.3 and 2.5 ± 1.9 plant bugs in monoculture and intercropping plots.

There were no significant treatment differences for yield in 1988, with a slight indication of interaction ($F = 3.50$; df = 1, 9; $P = 0.09$) between tillage and cropping system (Fig. 5). In 1989, conventional tillage plots had greater yield (6,248 ± 1,389 kg/ha) than no-tillage plots (5,262 ± 922 kg/ha; $F = 5.12$; df = 1, 9; $P = 0.05$) (Fig. 5). Also, there were significantly more ($F = 15.62$; df = 1, 9; $P = 0.0001$) plants per meter in conventional tillage plots (3.7 ± 0.3) than in no-tillage plots (2.7 ± 0.3). In 1990, there were no significant differences for total yields despite a trend for higher production in conventional tillage plots ($F = 4.27$; df = 1, 9; $P = 0.07$) (Fig. 5), but grain weight per plant was higher in conventional tillage (139.8 ± 28.3 g/plant) than in no-tillage plots (106.8 ± 19.9 g/plant; $F = 6.13$; df = 1, 9; $P = 0.03$). Root damage, western corn rootworm, and European corn borer densities were not significantly correlated with yield in any of the 3 yr.

Discussion

Cutworms, armyworms, and stalk borers are some of the insect pests of greatest concern in conservation-tillage systems (Musick 1987, Stinner & House 1990). However, despite the higher incidence of cutworms and armyworms in no-tillage corn, their damage only bordered the economic levels of 20–25% of plants damaged by armyworms and 3–5% of plants damaged by cutworms suggested by Wilson et al. (1980). However, slugs were a serious problem for no-tillage corn and soybean in 1989 and were the likely reason for differences in stand between tillage treatments. Precipitation was above normal during May and June (297.2 mm, about 47% more than the period's average) and created favorable conditions for the slug population at the highly susceptible seedling stage. The overall slug population measured by pitfall traps was highest in 1990 (unpublished data), but they occurred mostly at later stages of the growing season and no detectable damage to the crops was observed.

Results of adult counts and root damage indicate that both conventional tillage and intercropping increased densities of the western corn rootworm. The higher incidence in 1988 of adults in conventional tillage versus no-tillage but no differences in root damage support Gray & Tollefson's (1987) hypothesis that there is reduced survival of corn rootworms in no-tillage systems, which may be associated with higher weed density (Johnson et al. 1984). However, there was no significant tillage effect in 1989. The overall reduction of western corn rootworm densities from 1988 to 1989 was probably a consequence of crop rotation, lower larval survival, or both because of saturated soil conditions (Sutter et al. 1989).

An average of one beetle per plant is recommended as the threshold for economic damage in the following year (Turpin 1972, Willson & Eisley 1987). If the threshold is valid, crop rotation was not sufficient to reduce the incidence of western corn rootworm below the economic level on intercropped corn in 1989, nor on intercropped–conventional tillage corn in 1990 (Fig. 1). The root damage evaluation partially supported the results of adult counts; there were no differences in root damage in 1988, but the damage caused to intercropped corn in 1989 bordered the economic threshold suggested by Turpin et al. (1972). However, the economical implications should be viewed with caution; prediction of economic damage by scouting adults or rating roots is not consistent (Foster et al. 1986, Spike & Tollefson 1989), and the suggested level of 2.5 for root damage may be too low (Sutter et al. 1990).

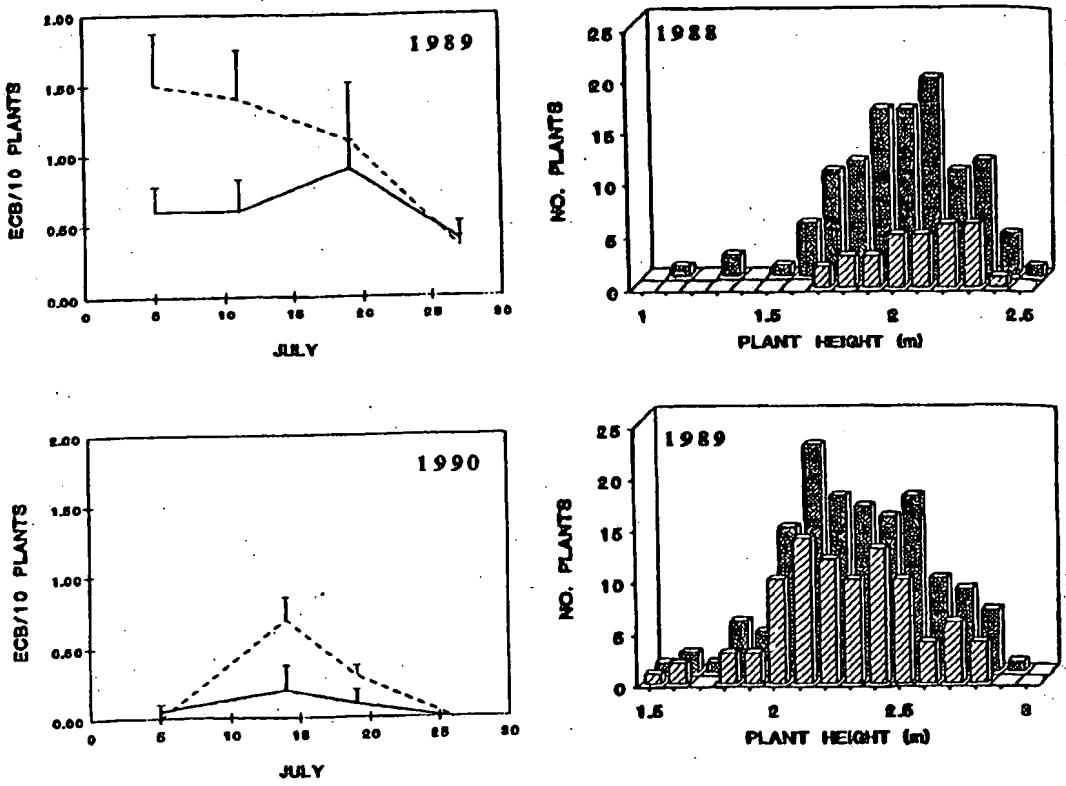
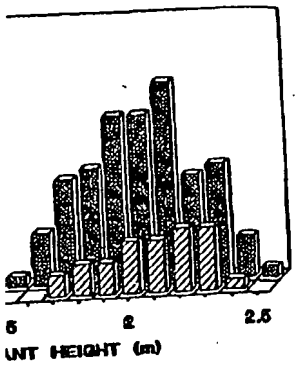


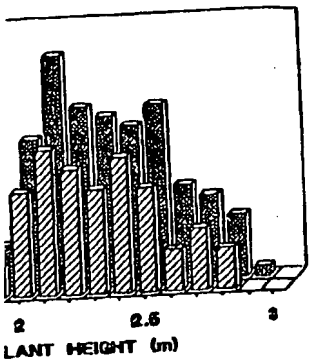
Fig. 3. Number of plants damaged by the first generation of the European corn borer (ECB) per 10 plants in 1989 and 1990. (——), no-tillage; (- - -), conventional tillage. Vertical lines are standard errors.

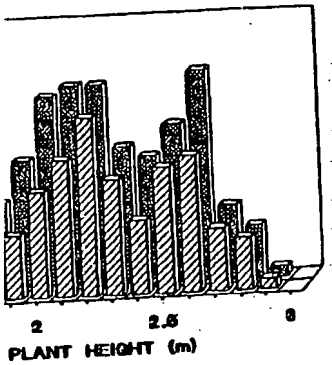
Fig. 4. Frequency distribution of the total number of plants sampled (▩) and plants infested by second generation European corn borers (▩) on plant-height classes in 1988, 1989, and 1990.

Apparently, females dispersing from corn strips laid enough eggs on soybean strips to maintain damaging levels on the corn strips in the next year, as corn rootworm adults commonly disperse to feed on other crops (Shaw et al. 1978). Corn rootworms have increased survival rates in soybean fields that contain volunteer corn (Shaw et al. 1978), therefore intercropping plots may have acted as a soybean crop "infested" by corn. Results of egg counts support this hypothesis, as does the number of adults collected in sweep net samples from soybeans (unpublished data). For example, on 24 August 1990, there were 15.6 ± 8.9 adults collected from intercropped soybean (80 sweeps/plot), but only 3.5 ± 2.7 adults on soybean monoculture. Another possible factor for higher numbers of western corn rootworm in intercropped corn could be larval dispersal: Short & Luedtke (1970) reported distances of up to 0.8 m from egg hatch to adult emergence sites. The 3.0-m corn strips could have been insufficient to prevent larval migration to corn strips in the next year.

In earlier reports on potential effects of reduced-tillage practices on corn insects, Musick & Petty (1973) and Gregory & Musick (1976) predicted that the incidence of European corn borer would increase under conservation tillage because of greater survival of overwintering larvae in corn stalks and weed stubble in the field, and longer predisposition of the crop to second-generation larvae because of slower crop development. However, infestation from adjacent fields may neutralize the effects of stubble destruction in conventional tillage fields (Wilson et al. 1980). Berry & Ghidiu (1989) reported that crop rotation combined with tillage







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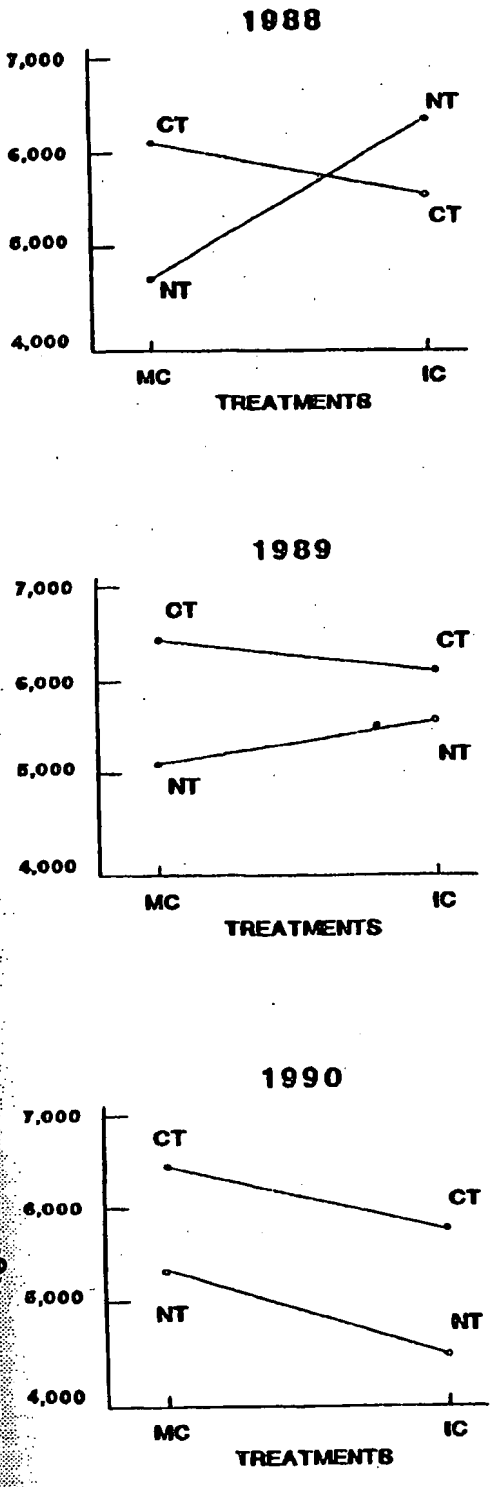

Fig. 5. Average corn yield for each of the four treatments; MC, monoculture; IC, intercropping; NT, no-tillage; and CT, conventional tillage.

treatments affected European corn borer populations in 6 of 8 yr of observations, but not in a clear pattern. Our results indicate that the European corn borer population was generally reduced by no-tillage practices. As concentration of DIMBOA (2-4-dihydroxy-7-methoxy-1,4-benzoxazin-3-one) is inversely proportional to plant height (Showers et al. 1983), small corn plants under no-tillage could have greater resistance to European corn borer because of slower development rates than under conventional tillage. However, this resistance would not be effective during later developmental stages, when the concentration of DIMBOA decreases. Despite a trend for higher numbers of European corn borer on taller plants, plant height was not a conclusive factor that determined level of infestation of the second generation for a given treatment in 1988 or in 1989. Only in 1990 was there an apparent association between individual plant height and infestation levels. The European corn borer is very susceptible to environmental conditions (Showers et al. 1983, Jarvis & Guthrie 1987), and one possible reason for low densities in 1988 was below-normal rainfall during early season. An additional reason for lower numbers of the first generation in 1988 could be a higher rate of predation; sweep net samples from soybean revealed a high population density of *Orius* spp. (unpublished data), which can exert a strong impact on European corn borer (Jarvis & Guthrie 1987). Higher population densities in 1989 and 1990 could have influenced insect response to plant size. As infested plants are less attractive to ovipositing moths (Everett et al. 1958), the more even distribution of the European corn borer across different plant sizes could be a result of fewer ideal oviposition sites.

In summary, tillage had a greater effect on the corn fauna included in this study than cropping systems. Cutworms, armyworms, and slugs were favored by no-tillage, although only slugs were a serious pest during one exceptionally wet early season. European corn borer and western corn rootworm densities were generally reduced in no-tillage plots, although the results were not consistent for the 3 yr. Results for ladybugs and plant bugs should be viewed with caution, because of their low numbers (particularly in 1988, a probable consequence of a very dry season), and because of statistically significant results in 1990 only. Although there were no conclusive correlations with yield, this study suggests that western corn rootworm densities may be increased by the strip-intercropping practice employed here, despite crop rotation.

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Abstract: We tested two agronomic practices that are likely to increase plant and structural diversity, no-tillage and strip intercropping, for effects on corn invertebrate fauna. Some of the most common herbivores and natural enemies were sampled by direct counts and damage estimation from 1988 through 1990 on monoculture corn and strips of corn alternated with soybean, under no-tillage and conventional tillage. Among soil pests, cut-worms (mostly the black cutworm, Agrotis ipsilon (Hufnagel)); armyworm, Pseudaletia unipuncta (Haworth); and slugs (Gastropoda) were more abundant in no-tillage plots, although only slugs caused severe damage. The western corn rootworm, Diabrotica virgifera virgifera LeConte, and the European corn borer, Ostrinia nubitalis (Hubner), were generally more abundant in conventional tillage plots. Despite crop rotation, the strip-intercropping system (four rows of each crop) was less effective in reducing western corn rootworm infestation, especially in conventional tillage plots. In 1990 only, ladybugs (mostly Coleomegilla maculata (DeGeer)) were more abundant in conventional tillage plots, whereas tarnished plant bugs, Lygus lineolaris (Palisot de Beauvois), were more abundant in no-tillage plots. Japanese beetle, Popillia japonica Newman; stink bugs, Acrosternum hilare (Say) and Euschistus serous (Say); and spiders (Aranea) were not significantly affected by treatments.

Bibliography Note: Includes references.

NAL Subject(s):
Zea mays
Agrotis ipsilon
Pseudaletia unipuncta
slugs
Diabrotica virgifera
Ostrinia nubilalis
intercropping
no-tillage
biological control agents
predators

NAL Geographic(s): Ohio

Other Subject(s): predators of insect pests

Subject Code(s):
F821
J700
F820

R. J. Wright et al. (Eds.), Plant-soil interactions at low pH, 431–435

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Effect of incorporated green manure crops on subsequent oat production in an acid, infertile silt loam

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Key words: alsike clover, buckwheat, green manures, low fertility, oats, red clover, sweet clover

Abstract

A field-size experiment was initiated in 1982 on an acid, low fertility Springhill silt loam to determine the effect of five unfertilized green manure crops (alsike clover, sweet clover, single- and double-cut red clover, and buckwheat) on subsequent oat production and soil fertility. The field was limed in 1982 and green manures were seeded (without fertilizer) in spring, 1983 in 1400 m^2 strips randomly assigned within three treatment blocks. Plant tissue samples were taken from different locations in each plot in the fall of 1983 and all crops were incorporated. In 1984 the field was separated into an upper and lower section and each section received three rates of NPK fertilizer (0; 30–36–36; 60–72–72 kg ha^{-1}) spread across the previous strips. Gary oats were seeded and at harvest were divided into grain and straw. The results indicated significant effects of field sample location, green manure type and fertilizer level on oat yields. Buckwheat significantly reduced oat production compared to the four clovers, while the highest fertilizer rate improved oat yields compared with the other levels of fertilizers. Elemental analysis of the green manure crops and soil fertility was compared with data of the same crops grown in more fertile, neutral soils.

Introduction

Agriculture has witnessed the resurgence of green manuring practices, partly due to the development of alternative and sustainable agriculture systems. Various green manure crops have been planted in soils as catch crops to conserve available plant nutrients and provide additional organic matter and/or nitrogen when incorporated (Pieters, 1927; Warman, 1980).

Some of the best work using green manures dates back to the early part of this century and is documented by Pieters (1972), McKee (1935) and others. More recently, workers have closely investigated crop rotation systems and the influence of both legume and nonlegume crops on subsequent small grain crops (Badaruddin and Meyer, 1989; Faris *et al.*, 1986; Hoyt and Leitch, 1983; Mann, 1959; Meyer, 1987). Most of the time forage legumes are the preferred plowdown crop because of their N fixation capacity and large quantity of top and root biomass. Some crops, notably sweet clover and buckwheat, are efficient utilizers of relatively unavailable soil phosphorus (Pieters, 1927); therefore, these crops may be superior green manure crops under low fertility conditions.

Acid soils and low soil fertility are common production problems in the Canadian Atlantic Provinces. Usually plowdown crops receive adequate nutrition from supplemental fertilizer or nutrients remaining in the soil from preceding crop fertilizers. However, there is little information regarding the growth of green manures and their impact on subsequent crops when the manures are grown in low fertility, acid soils. The objectives of this study, therefore, were to investigate the effect of five unfertilized green manure

crops on a subsequent oat crop fertilized at three different rates, and to compare the elemental composition of the five green manures with corresponding crops grown under high fertility conditions.

Materials and methods

A field experiment was initiated in 1982 on the Butlin farm near Tatamagouche, Nova Scotia (N latitude 45°43′, W longitude 63°16′). Following a fallow period of a few years, a 2.5 ha field of imperfectly drained Springhill silt loam was limed using dolomite at 4 Mg ha^{-1}. Five green manure treatments (strips of 14 m × 100 m) in three replicates were randomly assigned in the field such that the 100 m dimension extended up and down at 2–10° slope. Four inoculated clovers (alsike, sweet, single cut red and double cut red) and buckwheat were brillion seeded in June, 1983. The clovers were seeded at 12 kg ha^{-1}, the buckwheat at 88 kg ha^{-1}. None of the plots received supplemental fertilizer.

To determine the amount of plant biomass, random bulk samples (0–20 cm deep) of soil and plant material were taken from the top, middle and bottom of each clover green manure plot on November 1 immediately prior to incorporation. The combined plant and soil samples were dried to determine total mass, then the samples were wet sieved to separate the two components. Cleaned tissue was dried at 65° and reweighed to determine the proportion of plant biomass in the original field samples. The tissue was ground through a 40 mesh sieve in a Wiley mill and digested and analyzed using the H_2SO_4–H_2O_2 method of Thomas *et al.* (1967).

Buckwheat plants were taken from a 0.3 m^2 area of the same three regions of the plots on August 18, three weeks after flowering and just prior to incorporation. Buckwheat plants were cleaned and divided into tops and roots for tissue analysis.

Soil samples were taken from three sections of each plot at the time of green manure seeding. Samples were also taken at oat harvest in 1984. The 1983 soil samples were analyzed in the N.S. Soil and Feed Testing Lab for organic matter (loss on ignition), H_2O–pH; and ammonium acetate extractable K, Ca, and Mg. Bray extractable P, the only nutrient investigated in 1984, was analyzed in our lab both years.

The entire area was prepared for seeding May 27, 1984 using a tractor mounted Howard rotovator. Gary oats were drilled May 29 at 101 kg ha^{-1}. The field was separated into an upper and lower section, across all plots, and each section received three rates of fertilizer based on the soil test recommendation for oats. Treatments were 0, 150 kg ha^{-1} of 12–24–24 and 300 kg ha^{-1} of 12–24–24 spread across the previous green manure strips. Additional N fertilizer at 0, 36 and 72 kg ha^{-1} of 34–0–0 was applied July 10. Above ground oat yields were taken on August 31; samples were further separated into grain and straw.

Results and discussion

The total plant biomass data taken from the four legume plots indicated a trend of increasing percentage of biomass in the bulk samples (soil + plant) as one proceeded from the top to the bottom of the plots. Although the replicate data was variable, the range in percent biomass was 2.8 to 5.4 (mean 4.4) for alsike clover, 7.4 to 8.7 (mean 8.0) for sweet clover, 4.1 to 5.7 (mean 4.9) for single cut red clover, and 2.5 to 6.6 (mean 5.0) for double cut red clover. On the basis of these results, the sweet clover would have provided the largest amount of legume plant biomass for decomposition. The average dry matter yield contributed by the buckwheat was 2679 kg ha^{-1}; there was no difference in sample yield from the top to the bottom of the plots.

The mean elemental composition of the five green manure crops is found in Table 1. For simplicity, results from the middle sections of the plots are not shown. Although many of the plant samples taken from the lower parts of the plots were higher in elemental analysis, there was no significant difference between top and bottom plants.

Interesting comparisons can be made between the Table 1 data and elemental analysis of the same plant species grown at more fertile sites (Table 2). Buckwheat grown in a fertile Pugwash

Table 1. Elemental composition (g kg^{-1}) of green manure crops sampled at two locations in each plot

	N	P	K	Ca	Mg
Alsike clover					
Top	24.1	2.1	9.4	2.0	3.6
Bottom	28.7	2.4	10.6	3.2	3.6
Buckwheat					
Top	11.5(4.3[a])	1.4	12.1(8.3)	(7.6)	(4.9)
Bottom	11.8(5.0)	1.1	15.0(9.9)	(9.0)	(4.6)
Sweet clover					
Top	27.2	1.6	6.2	3.6	3.3
Bottom	30.4	1.3	7.2	4.3	3.7
Red clover (single cut)					
Top	23.4	2.2	8.4	1.9	3.5
Bottom	28.0	2.1	9.2	3.9	3.9
Red clover (double cut)					
Top	22.3	1.4	6.8	1.5	2.6
Bottom	31.4	1.7	7.7	3.4	4.1

[a] Data in parenthesis are buckwheat root samples.

Table 2. Elemental composition (g/kg) of green manures grown in fertilized soils and mine tailings

	N	P	K	Ca	Mg	References
Buckwheat	12.2	4.2	22.8	37.6	5.2	(Warman, 1988)
	12.0	3.7	28.5	–	–	unpublished
Red clover (s)	35.0	4.0	24.2	10.9	2.9	(Warman, 1990a)
	33.0	3.9	26.6	11.3	2.8	(Warman, 1990b)
Red clover (d)	26.6	2.3	18.8	32.5	3.4	(Warman, 1988)
	33.5	3.6	–	–	–	(Warman, 1990a)
	25.8	2.9	21.3	12.8	3.1	(Warman, 1990b)
Sweet clover	33.2	3.2	21.0	10.3	2.4	(Warman, 1990a)
	27.1	2.8	15.2	9.1	2.1	(Warman, 1990b)

sand loam and in mine tailings (Warman, 1988) which had received 400 kg ha^{-1} of 12–24–24 analyzed much higher in P, K, and Ca than that found in this study. Sweet clover samples from fertilized Pugwash sandy loam plots (Warman, 1990a, b) were considerably higher in P (2.8–3.2 kg ha^{-1}), K (15–21 kg ha^{-1}) and Ca (9.1–10.3 kg ha^{-1}) compared with this study's tissue. Single and double cut red clover were half to one third the P and K concentration and about one third the Ca concentration found in Warman (1988, 1990a, b). The N and Mg contents of all five green manures, however, were similar or even higher than the samples from the other cited studies.

Soil samples taken from three sections of each plot in 1983 revealed no significant differences between green manure plots or between sections of the field; thus, the field was uniform in fertility. The general trend, however, was higher levels of extractable macronutrients in the top compared with the bottom samples of the plots. The average soil test values were 49 g organic matter kg^{-1}, H_2O pH 6.02, 73 kg Bray P ha^{-1},

Table 3. Oat yields (grain + straw, g m^{-2}) at two locations in each plot following incorporated green manure crop

	Fertilizer applied (kg ha^{-1})						
	0		30–36–36		60–72–72		
Green manures	Upper	Lower	Upper	Lower	Upper	Lower	Mean[b]
Alsike clover	323	303	281	357	390	441	349b
Buckwheat	238	260	265	226	272	271	255a
Sweet clover	298	436	292	419	379	418	374b
Red clover (s)[a]	272	388	348	398	369	406	361b
Red clover (d)[a]	336	400	290	405	422	397	375b
Mean[b]	325a		328a		375b		

[a] (s) = single cut, (d) = double cut.
[b] Means in a row or column followed by the same letter are not significantly different at $P < 0.05$ using LSD.

73 kg extractable K ha^{-1}, 2126 kg extractable Ca ha^{-1}, and 303 kg extractable Mg ha^{-1}.

The results of the tissue analysis reflect the low levels of available P, K, and Ca in the Springhill silt loam and the fact that the lime applied in 1982 provided insufficient levels of available Ca. Tissue N levels were similar to Warman (1988, 1990a,b) primarily because of clovers' ability to fix nitrogen, while the relatively high tissue Mg levels were likely due to the mineralogical composition of the silt loam soil.

Table 3 summarized the results of the total oat yield at two sample locations, three supplemental fertilizer rates and five green manure crops. The results indicate that all four clovers were better green manure crops than buckwheat and that the highest fertilizer rate increased total oat yield compared with the lower rate or control. ANOVA also indicated that sampling within a plot was highly significant; plants grown in the lower areas of the plots produced higher yields. There were no significant interactions between fertilizer rate, green manure crop or sampling location. Evaluation of the data on grain yield and straw yield indicated a similar response to the rate, crop, and location variables as shown above. Overall mean grain yield was 165 g m^{-2} (1650 kg ha^{-1}) while mean straw yield was 176 g m^{-2} (1760 kg ha^{-1}).

Extractable soil P in the 1984 samples did not differ between green manure crops or between the upper and lower sections of the field; both sections averaged 77 kg P ha^{-1} over all treatments. As anticipated, fertilizer additions affected extractable P at harvest. Soil P averaged 64 kg ha^{-1} for 0 fertilizer, 73 kg P ha^{-1} for the 30–36–36 treatment, and 94 kg P ha^{-1} for the 60–72–72 treatment. Thus, soil P increased 30 kg ha^{-1} from the application of 31.4 kg P ha^{-1}, while the intermediate rate (15.7 kg P ha^{-1}) just maintained the original level of extractable P.

Conclusions

Elemental mineral analysis showed that green manure crops grown in an infertile soil suffer from low mineral nutrition. Soil P and K was limiting and although limed to pH 6.0, tissue Ca levels were considerably lower than the same crops grown in fertile soils or fertilized mine tailings. Buckwheat was not as effective a green manure crop as the four clovers, partly because early maturing buckwheat seeds produced competing plants the following year; furthermore, since buckwheat does not fix N, the crop returns less N to the soil during mineralization. Summarized over all treatments, the green manures provided the equivalent nutrient value to subsequent oats as an NPK fertilizer application of 30–36–36.

Acknowledgements

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Article Title: Effect of incorporated green manure crops on subsequent oat production in an acid, infertile silt loam.

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Call Number S596.7.D4

Abstract: A field-size experiment was initiated in 1982 on an acid, low fertility Springhill silt loam to determine the effect of five unfertilized green manure crops (alsike clover, sweet clover, single- and double-cut red clover, and buckwheat) on subsequent oat production and soil fertility. The field was limed in 1982 and green manures were seeded (without fertilizer) in spring, 1983 in 1400 m2 strips randomly assigned within three treatment blocks. Plant tissue samples were taken from different locations in each plot in the fall of 1983 and all crops were incorporated. In 1984 the field was separated into an upper and lower section and each section received three rates of NPK fertilizer (0; 30-36-36; 60-72-72 kg per ha-1) spread across the previous strips. Gary oats were seeded and at harvest were divided into grain and straw. The results indicated significant effects of field sample location, green manure type and fertilizer level on oat yields. Buckwheat significantly reduced oat production compared to the four clovers, while the highest fertilizer rate improved oat yields compared with the other levels of fertilizers. Elemental analysis of the green manure crops and soil fertility was compared with data of the same crops grown in more fertile, neutral soils.

Bibliography Note: Includes references.

NAL Subject(s):
acid soils
silt loam soils
green manures
Oryza sativa
crop yield

Subject Code(s):
J200
J700

Exhibit D

March 26, 2006

To: United States Patent & Trademark Office

P.O. Box 1450

Alexandria, Virginia 22313-1450

REPLY TO SECOND FINAL OFFICE ACTION AND REQUEST FOR RECONSIDERATION

Re: U.S. Application No.: 10/747,728

Filing Date: December 29, 2 003

Inventor and Applicant: Marvin J. Williams, Jr.

Examiner: Jeffrey L. Gellner

Art Unit: 3643

Dear Sir or Madam:

Applicant responds to the final office action of February 10, 2006 in the above captioned matter as follows:

The amendments to the specification begin on page 2 of this paper.

The amendments to the claims begin on page 11 of this paper.

The Brief begins on page 20 of this paper.

The Remarks begin on page 26 of this paper.

The Request for Reconsideration begins on page 27 of this paper.

IN THE SPECIFICATION

Please amend paragraph 4 of the specification as follows:

(4) My preferred method of intercropping comprises strip cropping corn and soybeans with subsequent application of green manure to the soil, and a layer of mulch upon the topsoil surface. My method does not require pesticides, herbicides or artificial fertilizers for healthy crops, [or] nor to obtain an effective ground cover and subsoil root network with an effective moisture canopy and windbreak.

Please amend paragraph 6 of the specification as follows:

(6) Green manure plants combined with organic residue from deceased crops contains desiccated soybean roots and nitrogen nodules which remain intact in the soil. During the winter months, the intact root systems of these nonviable soybean and corn (and viable wheat) also function as ground cover and subsoil root retention system. In this manner, intact soybean and corn roots provide a physical soil network for the no till planting of a green manure crop (for example wheat and buckwheat grass) in the fall or early spring as the case may be. For example, wheat and buckwheat ~~grass~~ [[is]] are planted in the fall or early spring, and [[is]] are subsequently tilled into the soil as green manure while green and viable.

Please amend paragraph 17 as follows:

(17) Eadie et al. reported the effect of cereal cover crops upon weed control. The investigators hand planted cereal seed within plots which were approximately 2.3 meters wide and 8.0 meters long. The rows were approximately at 0.75 meter equidistantly

spaced intervals. These investigators seeded the cereal cover crops immediately after the ridging cultivation at the 11-12 leaf stage of corn plants. According to the Eadie report, corn grain yields remained unchanged by cover crops seeded at the 11-12 leaf stage of corn, compared to bare soil treatment controls. Allan G. Eadie et al., "Integration of Cereal Cover Crops in a Ridge-Tillage Corn Production," WEED TECHNOLOGY 6 (3) (July-September 1992).

Please amend paragraph 20 as follows:

(20) At least one farmer has reported that closer planting of crops in rows results in more equitable distribution of sunlight, soil moisture and nutrients. NO TILL FARMER (mid-January 1986).

Please amend paragraph 25 as follows:

(25) Intercropping also comprises the growth of quick-maturing vegetable crops between slower developing crops, to maximize available garden or field space. For example, soybeans are planted in spring or summer at 2 to 3 pounds of seeds per 1,000 square feet in traditional commercial situations. Soybeans are annuals and must be re-seeded every year; however, they tolerate poor drainage well[[,]] and are ideal for nitrogen fixation. Plants such as adzuki and muny beans are fairly resistant to insect pests.

Please amend paragraph 44 as follows:

(44) Figure 4 is a lateral view of mowed upper portions of wheat and buckwheat, ~~grass and~~ resulting in a twenty foot path prior to tillage, and with adjacent unmowed upper portions of wheat and buckwheat ~~grass~~.

Please amend paragraph 47 as follows:

(47) Figure 7 illustrates soil of Figure 5 treated by a third tilling machine to a final greatest depth within a twenty-foot width path, and with adjacent unmowed upper portions of wheat and buckwheat ~~grass~~.

Please amend paragraph 75 as follows:

(75) The recommended conventional no-till seeding machine 84 for wheat 17 and buckwheat 18 is a CASE 5400 no till grain drill. However, a JOHN DEERE 560 no-till drill, or a JOHN DEERE 1860 no-till air drill are also satisfactory. Referring to Figure 3, by the following spring young wheat [[17]] and/or buckwheat plants [[18]] 18a ~~comprise wheat grass 18a which~~ is approximately 14 to 20 inches in height.

Please amend paragraph 78 as follows:

(78) Referring to Figure 3, ~~wheat grass 18a (consisting of~~ the upper portions of young wheat [[17]] and/or buckwheat [[18]] plants 18a ~~) remains~~ remain viable until it is mowed immediately prior to spring tilling. The top approximate one-half of the upper portions of young wheat and/or buckwheat plants ~~wheat grass~~ 18a is chopped and blended with organic debris 19 to become combined mulch 20, as explained in more detail *infra*. The remaining approximately one-half of the bottom portions of green manure plants 44 (such as upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a), is tilled into soil 45 with organic debris 19 prior to spring seeding of intercropped commercial plants.

Please amend paragraph 79 as follows:

(79) Referring to Figure 4, in the preferred embodiment and best mode the farmer mows upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a, residual corn stalks 5 and organic debris 19 approximately three inches to ten inches above soil 45. The determination of the exact height of mowed upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a to properly cover soil 45 is empirical. This determination also depends upon leaf density of upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a. Leaf density primarily depends upon nutrients in the soil, weather conditions, and time of the year, including the required 60 degrees Fahrenheit (F.) soil temperature. Consequently, each field has a different leaf density and different plant heights.

Please amend paragraph 80 as follows:

(80) Buckwheat [[17]] 18 is generally mowed along with wheat 17 ~~grass 18a~~. However, buckwheat [[17b]] 18 can be reseeded with corn 10 and soybean seed 12 for a summer planting, to produce additional nutrients. Please see Figure 11. The recommended conventional machine for mowing upper portions of young wheat and/or buckwheat ~~grass~~ 18a, residual cornstalks 5 and residual soybean 16 stems (thereby creating combined mulch 20) is prior art INTERNATIONAL 650 Forage Harvester. This particular mowing machine comprises a cutting bar unit and is available from:

International Harvester Company

401 North Michigan Avenue

Chicago, Illinois 60611

Please amend paragraph 81 as follows:

(81) INTERNATIONAL 650 Forage Harvester mows, rakes and collects mowed green manure plants 44a and organic debris 19 for a lateral distance 101 of approximate twenty

feet across a field. INTERNATIONAL 650 Forage Harvester simultaneously mows and blows upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a into towed forage wagon 51, for storage prior to mixing and chopping within bale chopper 108, infra. INTERNATIONAL 650 Forage Harvester both mows and collects upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a for larger commercial fields, while conventional small mowing and gathering tools are satisfactory for gardens and small fields.

Please amend paragraph 82 as follows:

(82) A 5460 or 5440 Forage Harvester with mower bar unit is also satisfactory, as well as other farm machinery for cutting and collecting mowed upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a. Forage Harvesters are self-propelled forage harvesters 50 from John Deere, Inc. With a 5460 or 5440 Forage Harvester the farmer mows an approximately 20 feet wide interval of upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a in the first step of process 110. However, Forage Harvesters can only collect a portion of the mowed upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a within a twenty-foot wide path, so two passes may be necessary.

Please amend paragraph 84 as follows:

(84) Immediately after mowing of the first twenty-foot width 101 of upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a, the farmer quickly tills soil 45 with organic residue 19 (such as cornstalks 5) and a three-inch stubble of remaining soybeans

16, along with a portion of wheat grass 18a. Figure 5. A preferred conventional machine 58 tilling is the 3800 series field cultivator for larger commercial fields from:

AGCO® GLENCOE®

4205 River Green Parkway

Duluth, Georgia 30096

1-800-767-3221

or

Kuhn EL 201/400

5390 East Seneca Street

Vernon, New York. 13426-0840

Please amend paragraph 127 as follows:

(127) A John Deere 541 Series Loader 200 with attached fork lift 203 is the preferred front end loader and forklift of choice. However other front end loaders 200 and fork lifts 203 are satisfactory, depending upon compatibility with a farmer's equipment. As seen in Figure 13, front end loader 200 pushes seed drill 96 while corn planter 95 follows behind tractor 97 and linearly deposits corn 10 within corn furrows 90. Referring to Figure 14, in the best mode the farmer attaches corn planter 95 to tractor 97 posterior, using a three point hitch 230a or a one point tug hitch 230b, and both of which are familiar to the agricultural industry.

Please amend paragraph 134 as follows:

(134) Prior art bale chopper 108 chops organic debris 19 over soil 45, along with corn stalks 5, soybean stems and mowed green manure plants 44a (preferably upper portions

of young wheat and buckwheat plants ~~grass~~ 18a) as combination mulch 20. Several seconds is the ideal maximum time interval between procedures for seeding and mulching during method 110. However, a time interval of no more than approximately two hours between seeding and mulching a twenty foot pass width is satisfactory.

Please amend paragraph 136 as follows:

(136) The preferred prior art forage box wagons 51 for temporarily storing large amounts of combined chopped mowed upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a and organic debris 19 is available from:

H&S Manufacturing Co., Inc.

2608 South Hume Avenue

P.O. Box 768

Telephone: 1-715-387-3414

Marshfield, Wisconsin 54449

Models: HD7+4 & HD Twin Auger;

HD7+4 HDTwin Auger-front and rear unload; and

power box-rear unload

Please amend paragraph 137 as follows:

(137) For smaller amounts of upper portions of young wheat and/or buckwheat plants ~~grass~~ 18a and organic debris 19, preferred Versa Vac storage box wagons (conventionally used for grass clippings and leaf pick-up) are available from:

Fuerst Brothers, Inc.

P.O. Box 427

Gibson City, IL.

1-800-435-9630,

Models: M180G, M500P, M500G, M900P, and M900G.

Fuerst Manure Spreaders are also satisfactory and are distributed by:

H.F.S. Tractor

1218 South 11th Street

Niles, Michigan

1-616-683-7272

Please amend paragraph 150 as follows:

(150) (b) Also early in May of the same growing season, green manure plants 44a and organic crop debris 19 are mowed and raked. One portion of combined green manure 44(i.e, green manure plants and organic crop debris 19)is briefly stored for combination mulch 20, as described supra. In the best mode upper portions of young wheat ~~grass 18a~~ and/or buckwheat plants [[17]] 18a comprising green manure 44 are cut approximately three to ten inches above soil 45.

(i) approximately one/half of combination green manure 44 and organic residue 19 is tilled approximately four inches into soil 45.

(ii) the farmer then tills soil 45 and organic residue 19 to a depth of approximately nine to 14 inches in large commercial fields and approximately four to nine inches in depth in a garden. He then immediately seeds corn 10 and soybeans 12, covers them with

soil 45, and lastly covers the soil with combination mulch 20 to approximately 1/2 inch in depth.

Please amend the ABSTRACT as follows:

ABSTRACT

A method of combined intercropping and mulching of commercial crops is described herein. [[A]]Suitable annuals ~~suitable annual~~ such as young wheat and/or buckwheat plants are [[is]] planted in soil in which legumes were originally planted. A portion of the resulting upper portions of young wheat and/or buckwheat plants ~~wheat grass~~ is mowed and blended with organic debris to provide nutrients for intercropped commercial plants such as corn and soybeans. The remaining portion is chopped blended with organic debris and sprayed onto the top layer of seeded soil as combination mulch. For larger commercial applications, conventional agricultural machines are described herein, and are modified for the most efficient intercropping. For best results, at least one intercropped commercial plant should be a legume.

IN THE CLAIMS

1. Please amend Claim 1 as follows:

(Currently amended) Claim 1: An improved intercropping and mulching method without artificial herbicides, fertilizer, pesticides and manure, said improved intercropping and mulching method comprising:

(1) no-till planting an annual green manure crop in the soil of a predetermined area;

(2) mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue from said predetermined area to form combined green manure, said organic residue comprising desiccated intact soybean roots and desiccated intact nitrogen nodules, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area to a depth of approximately nine to fourteen inches, ~~said first portion of said combined green manure becoming a combination mulch,,~~ said annual green manure crop remaining unmowed until tillage of said soil,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure, <u>said</u> <u>first portion of said combined green manure</u>

being collected, chopped and stored until intercropping is complete, said first portion of said combined green manure becoming said combination mulch after said chopping,

(4) thereafter spraying said first portion of said combination mulch upon the surface of said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby, said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two commercial crops, said annual green manure crop and said organic residue protecting said soil of said predetermined area during the winter.

(Previously presented) Claim 2. The improved intercropping and mulching method as described in Claim 1, wherein one of said at least two commercial crops comprises a legume.

(Previously presented) Claim 3. The improved intercropping and mulching method as described in Claim 1, wherein one of said at least two commercial crops comprises soybeans.

(Previously presented) Claim 4. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn.

(Previously presented) Claim 5. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn and one of said at least two commercial crops comprises soybeans.

(Previously presented) Claim 6. The improved intercropping and mulching method as described in Claim 1, wherein there are no intercropped plants other than said at least two commercial crops, said at least two commercial crops comprising said corn and said soybeans.

(Previously presented) Claim 7. The improved intercropping and mulching method as described in Claim 6 wherein said corn and said soybeans are planted in alternating patterns comprising soybean areas and corn rows, each said soybean area and said corn row comprising a predetermined lateral width.

(Previously presented) Claim 8. The improved intercropping and mulching method as described in Claim 7, wherein said annual green manure crop comprises buckwheat.

Please amend amended independent Claim 9 as follows:

(Currently amended) An improved intercropping and mulching method comprising:

(1) planting an annual green manure crop in the soil of a predetermined area;

(2) mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue to form combined green manure, said combined green manure comprising a first portion of said combined green manure and a

second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area, said first portion of said combined green manure ~~becoming a combination mulch,~~ being mechanically collected and mechanically chopped and thereby becoming a combination mulch,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure, said combination mulch being stored during said intercropping,

(4) thereafter spraying said first portion of said combined combination mulch upon said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two commercial crops, said annual green manure crop and said organic residue protecting said soil of said predetermined area during the winter,

one of said at least two commercial crops comprising a legume,

one of said two commercial crops further comprising soybeans,

one of said at least two commercial crops comprising corn,

said at least two commercial crops comprising corn and soybeans,

there being no intercropped plants other than said at least two commercial crops comprising corn and soybeans,

said corn and said soybeans planted in alternating patterns comprising corn rows and soybean areas respectively, each said soybean area and said corn row comprising a predetermined lateral width,

said annual green manure crop selected from the group consisting of buckwheat or buckwheat and wheat, Austrian peas, hairy vetch, soybeans, annual rye grass and winter rye.

(Previously presented) Claim 10. The improved intercropping and mulching method as described in Claim 9, wherein said annual green manure crops are mowed with a conventional mechanical forage harvester.

(Previously presented) Claim 11.

The improved intercropping and mulching method as described in Claim 10,

wherein said combination green manure is sprayed upon said soil of said predetermined area after blending and chopping of said green manure plants and organic debris within a bale chopper.

(Previously presented) Claim 12. The improved intercropping and mulching method as described in Claim 11 wherein said intercropped soybeans are planted simultaneously with said intercropped corn by using a fork lift attachment with two forks, front end loader and tractor, corn planter, and a modified seed drill, said modified seed drill and

said fork lift attaching to said tractor by said front end loader, said fork lift attachment elevated with a hydraulic lift and a retrofit adapter.

(Previously presented) Claim 13. The improved intercropping and mulching method as described in Claim 12 wherein said corn planter deposits said corn seeds between previously planted said soybean areas, said soybean areas consisting of soybean subrows, said soybean subrows deposited by said modified seed drill attached to said tractor, said corn seeds deposited within straight corn furrows.

Please amend amended Claim 14 as follows:

(Currently amended) Claim 14. An improved intercropping and mulching method for corn and soybeans comprising:

(A) planting a commercial legume crop in the soil of a predetermined area during the summer, said commercial legume crop forming organic debris within said soil after harvesting of said commercial legume crop,

(B) no-till planting buckwheat and wheat during the following fall in said soil of said predetermined area, said buckwheat and said wheat growing until the following spring, said buckwheat and said wheat covering said soil during the winter,

[[(B)]] (C) mowing said buckwheat and said wheat during said following spring, said mowing accomplished by forage harvester,

a second portion of said buckwheat and wheat forming an annual green manure for said soil of said predetermined area, said organic debris also comprising said second portion,

a first portion of said buckwheat and said wheat forming a combination mulch for said soil, said combination mulch further comprising said organic debris, said first portion being mechanically collected and chopped prior to becoming said combination mulch, said combination mulch being stored in a forage box wagon,

(D) creating consecutive corn rows, each said corn row comprising three subrows of soybean seeds within a soybean area, each said corn row further comprising one corn furrow,

(E) seeding said soybean seeds in alternating said soybean areas within said consecutive corn rows by using a modified seed drill and a fork lift with a front end loader and a tractor, said tractor comprising a tractor center,

said modified seed drill comprising sets of three tru-vee openers along a horizontal opener draw bar, said fork lift rigidly attached to said modified seed drill by a first fork and second fork, said forks attaching to said modified seed drill by enclosing one set of said tru-vee openers, said modified seed drill aligned with said tractor so said soybean seeds deposit directly beneath and anterior to [[the]] said tractor center,

(F) seeding said corn seed with a corn planter attached posterior to said tractor, said corn planter creating said corn furrows within said soil corn, said corn furrows containing linearly deposited said corn seeds, said corn furrows spaced laterally from each other approximately 30 inches, said soybean subrows located approximately midway between two consecutive said corn furrows,

(G) covering said seeded soil with said combination mulch, said first portion of said green manure plants and organic debris placed within a forage box wagon prior to chopping within said bale chopper to form said combination mulch, said combination mulch sprayed onto said soil of said predetermined area with a hose attached to a bale chopper mounted to said forage box wagon.

(Previously presented) Claim 15. The method described in Claim 14 wherein said soybean seeds are planted at approximately eight to twenty seeds per square foot of said soil and said corn seeds are planted at approximately one corn seed per eight linear inches of said soil, said soybean seeds planted during the same pass across said preselected soil as said corn seeds.

(Previously presented) Claim 16. The method described in Claim 14 wherein said modified seed drill comprises eight said sets of said tru-vee openers and one center bar, a single said set of said tru-vee openers fitting between said first and second forks, said single set of tru-vee openers positioned immediately proximal to either side of said center bar, each said first and second fork resting upon said opener draw bar on either side of said single said set of said tru-vee openers, each said first and second fork attached to said opener draw bar by a clamp.

(Previously presented) Claim 17. The method described in Claim 14 wherein each said three soybean subrows comprising a soybean area is approximately 21 inches in lateral width.

(Previously presented) Claim 18. The method as described in Claim 14 wherein rotating augers pull said organic debris and said green manure plants from said forage wagon into said bale chopper, said bale chopper attaching to a discharge opening by sliding said bale chopper until interior surfaces of a bale tube fit snugly over exterior surfaces of panels of said storage box wagon.

(Previously presented) Claim 19. The method as described in Claim 14 wherein said true-vee openers are arranged in said sets of three, thereby leaving lateral space between each said set along said horizontal bar, each said set seeding soybeans within said three said soybean subrows when said modified seed drill is pulled by said tractor, each said lateral space seeded with said corn seed within said corn furrows while said corn planter is pulled by said tractor, said seeding of said corn seed and said soybean seed occurring with said modified seed drill and said corn planter operatively attached to a single tractor.

(Previously presented) Claim 20. The method as described in Claim 19 wherein said two sides of a bale tube attach to said bale chopper, said two sides of said bale tube snugly fitting over an anterior and posterior panel, said anterior and posterior panels surrounding augers of said forage box wagon, said sides of said bale tube mechanically attached to said anterior and posterior panels, said forage box wagon physically attaching to said bale chopper main frame with L-brackets, said green manure plants and organic

BRIEF

I. The specification as originally filed is enabling according to 35 U.S.C. 112, first paragraph.

In support of its conclusion that the specification and claims are not enabling, the government states in relevant part:

"the harvesting of the first portion of the annual green crop and its mixing to become a combined green manure is critical or essential to the practice of the invention, but not(sic) included in the claim(s) (sic)is not enabled by the disclosure."

February 10, 2006 Office Action, Page 2, third paragraph.

However, Applicant observes that there are numerous passages within the specification which explicitly enable the amended claims. *See* Application, paragraph 66 (combination mulch 20 is collected in a forage box wagon); Application, paragraph 78 (top approximate one-half of the upper portion of young wheat and/or buckwheat plants 18a is chopped and blended with organic debris 19).

In particular, paragraph 81 describes:

(i) how mowed green manure plants and organic debris 19 are gathered by a particular machine, and

(ii) how this machine simultaneously mows, collects and blows upper portions of young wheat and/or buckwheat plants 18a, along with organic debris 19,

(iii) into a forage wagon for storage prior to mixing and chopping within a bale chopper. Paragraphs 133 through 145 describe in further detail exactly how corn stalks, organic debris and mowed green manure plants are blown into a forage wagon and chopped therein by machines. These paragraphs also describe how the green manure plants, cornstalks and organic debris are initially mixed by this blowing as they enter the forage wagon. Paragraphs 146 through 148 specify how combination mulch is sprayed on the soil with machinery and an attached hose. See also Figures 19 and 20.

Based upon the above paragraphs which contain the information which the government requires, Applicant concludes that his specification as originally filed enables his amended claims.

II. Procedural concerns

When rejecting claims under section 112, first paragraph, the government must explain why nothing within the scope of the claims is enabled. MPEP 706.03(c). In the pending case the government has not done so, nor has it suggested claims which are enabled by the disclosure. Moreover, Applicant overcame all the original rejections, yet was subsequently presented with an entire new legal basis for rejection of the entire

application. MPEP 707.07(g)(for a major technical rejection, there should be a full development of the reasons for a major technical rejection.))

A second office action should be final unless the government introduces a new ground of rejection which is not required by an applicant's amendment of the claims. MPEP 706.07(a). In the pending case applicant overcome the rejections of the first office action, see February 10, 2006 Final Office Action, page 3, line 1. However, the rejection of the entire application based upon section 112 was an entirely new ground of rejection which was not required by Applicant's amendment of the claims.

As a result, the government's final office action was premature. MPEP 706.07(c) (any question as to a premature final rejection should be raised while the application is pending before the primary examiner.) Applicant respectively requests that the finality of this office action be withdrawn. MPE P 714.12; 37 C.F.R. 1.116(b).

III. Under section 112, first paragraph, Applicant's invention does not require undue experimentation to use or create.

Applicant's originally filed specification explicitly describes the steps which were the basis for the final rejection. However, even if Applicant's application had not explicitly included these steps, their description is unnecessary if the written description otherwise permits those skilled in the art to make and use the invention. MPEP 2164 second paragraph *citing* CFMT, Inc. v. Yieldup Int'l Corp. 349 F.3d 1333, 1338, 68 U.S.P.Q.2d 1940, 1944 (Fed. Cir. 2003) (an invention directed to a general system to improve the

cleaning process for semiconductor wafers was enabled by a disclosure of improvements in the overall system).

The proper test for enablement is: Whether undue experimentation is required to practice the invention. MPEP 2164.01 *citing* Mineral Separation v. Hyde, 242 U.S. 261, 270 (1916), *followed by* In re Wands, 858 F.2dd 731, 737, 8 U.S.P.Q2d 1400, 1404 (Fed. Cir. 1988). A patent need not teach, and preferably omits, what is well known in the art. MPEP 2164.01, *citing* In re Buchner, 929 F.2d 660, 661, 18 U.S.P.Q.2d 1331, 1332 (Fed. Cir.1991). The test is not whether experimentation is necessary but whether, if necessary, the experimentation is undue. MPEP 2164.01 *citing* In re Angstadt, 537 F.2d 498, 504, 190 U.S.P.Q. 214, 219 (C.C.P.A. 1976).

Undue experimentation factors which courts consider include:

(1) Breadth of the claims;

(2) Nature of the invention;

(3) State of the prior art;

(4) Level of one of ordinary skill;

(5) Level of predictability in the art;

(6) Amount of direction provided by the inventor;

(7) Existence of working examples; and

(8) Quantity of experimentation needed to make or use the invention based upon the content of the disclosure.

MPEP 2164.01(a) *citing* In re Wands, 858 F .2d at 737.

Furthermore, if a statement of utility in the specification contains a connotation of how to use, and/or the art recognizes that standard modes of use, then this specification is sufficiently enabling. MPEP 2164.01(c), *citing* In re Brana, 51 F.3d 1560, 1566, 34 U.S.P.Q.2d 1437, 1441 (Fed. Cir. 1993). The amount of guidance for enablement of an invention is inversely related to the knowledge and predictability of that art. MPEP 2164.03 *citing* In re Fisher, 427 F.2d 833, 839, 166 USPQ 18, 24 (C.C.P.A. 1970).

In the pending case the government has not addressed any of the above considerations and factors, and consequently it should withdraw its rejection of Applicant's application and claims.

IV. Prior art references

The government cites the following as prior art upon which it did not rely: Tonhasca, Jr. et al, "Effects of Strip Intercropping and No-Tillage on Some Pests and Beneficial Invertebrates of Corn in Ohio," *Environmental Entomology*, Vol. 20: 5, 1251-1258 (1991). According to this study adult crop and root damage by western corn rootworm increased with respect to conventional tillage and intercropping. There was o application of chemical pesticides which teach away from Applicant's invention. In addition, there is no procedure for mixing, chopping, and spraying combination mulch upon previously intercropped seeded soil which already contains green manure plants.

The government also cited the following reference without relying upon it for an enablement rejection: P.R. Warman, " Effect of Incorporated green manure crops on

subsequent and production in an acid infertile silt loam," Developments *in Plant Soil Science*, 45:431-435 ((1991). For this study the scientists grew green manure crops on fields in which they subsequently planted oats.

This study concluded that (i) buckwheat green manure significantly reduced oat production compared to clover green manure; and (ii) the highest concentration of artificial chemical fertilizer rates improved oat yields. Applicant's invention contains no artificial chemical fertilizer, and this study does not disclose mulch of wheat grass and cornstalks, which is applied on two separate occasions during the growing season.

REMARKS

1. Independent amended Claims 1,9 and 14 have been currently amended to place this application in condition for allowance. MPEP 714.13 II (amendment removes issues for appeal and adopts examiner's suggestions). Applicant did not submit these amendments earlier, because the government did not raise the enablement rejection to Applicant's application until the February 10, 2006 Office Action. 35 C .F.R. 1.116(b)(3).

2. The current amendments respond to the government's requirement that Applicant incorporate the method steps between mowing and spraying of combination mulch of the "first portion'' within each independent claim. Applicant has added these features to each claim with respect to chopping and storing prior to spraying of combination mulch. The technical description within the application paragraphs cited *supra* supports the currently amended claims. Section 112, first paragraph.

3. Pursuant to the government's request, the term --wheat grass-- is changed to " the upper portions of young wheat and/or buckwheat plants" for consistency with the original specification. *See* Application, paragraph 78, and first sentence.

Request for Reconsideration and Preparation for Allowance

Based upon the above reasons and analysis and amended claims, Applicant respectfully requests that the government withdraw its rejection of the claims and specification based upon non-enablement and prepare the application for allowance.

Respectively submitted,

Adrienne B. Naumann, Esq.

Reg. No. 33,844

On behalf of

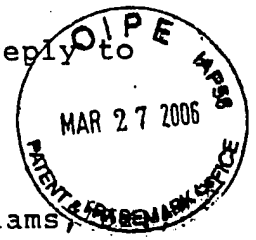
Marvin J. Williams, Jr.

Applicant and Inventor

This card knowleges the PTO's receipt of the following:

1. 27 page (consecutively numbered) reply to second/final office action

2. government transmittal form



Inventor and Applicant: Marvin J. Williams; U.S. Application No. 10/747,728; filing date: 12-29-2003; art unit 3643; Examiner: Jeffrey L. Gellner; Attorney of Record: Adrienne B. Naumann; phone: 847-329-8185; fax: 847-329-8750; Title: Combined INtercropping and Mulching Method; U.S. Express Mail No. EQ 471 793 349 US

Exhibit E

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/747,728	12/29/2003	Marvin J. Williams JR.		2033

31156 7590 04/04/2006

LAW OFFICE OF ADRIENNE B. NAUMANN
8210 NORTH TRIPP
SKOKIE, IL 60076

EXAMINER	
GELLNER, JEFFREY L	

ART UNIT	PAPER NUMBER
3643	

DATE MAILED: 04/04/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Advisory Action Before the Filing of an Appeal Brief	Application No. 10/747,728	Applicant(s) WILLIAMS, MARVIN J.
	Examiner Jeffrey L. Gellner	Art Unit 3643

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 27 March 2006 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☐ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:

   a) ☐ The period for reply expires _____ months from the mailing date of the final rejection.

   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.

   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☒ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because

   (a) ☒ They raise new issues that would require further consideration and/or search (see NOTE below);

   (b) ☐ They raise the issue of new matter (see NOTE below);

   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or

   (d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: *See Continuation Sheet*. (See 37 CFR 1.116 and 41.33(a)).

4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).

5. ☐ Applicant's reply has overcome the following rejection(s): _____.

6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).

7. ☐ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.

   The status of the claim(s) is (or will be) as follows:

   Claim(s) allowed: _____.

   Claim(s) objected to: _____.

   Claim(s) rejected: _____.

   Claim(s) withdrawn from consideration: _____.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).

9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).

10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.

12. ☐ Note the attached Information Disclosure Statement(s). (PTO/SB/08 or PTO-1449) Paper No(s). _____

13. ☐ Other: _____.

Jeffrey L. Gellner
Primary Examiner
Art Unit: 3643

Continuation of 3. NOTE: The amended language of claims 1 and 14 would require further consideration.

Application No.

Exhibit F

PTO/SB/31 (04-05)
Approved for use through 07/31/2006. OMB 0651-0031
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

NOTICE OF APPEAL FROM THE EXAMINER TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Docket Number (Optional)

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] Express Mail EQ471792 198US on 5-5-06

Signature Adrienne B. Naumann

Typed or printed name Adrienne B. Naumann

In re Application of Marvin J. Williams, Jr.

Application Number	Filed
10/747,728	12/29/2003

For Improved Combined Intercrop Mulch Method

Art Unit	Examiner
3643	J.L. Gellner

Applicant hereby appeals to the Board of Patent Appeals and Interferences from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 500.00

☒ Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ 250.00

☒ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account. I have enclosed a duplicate copy of this sheet.

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. _____. I have enclosed a duplicate copy of this sheet.

☐ A petition for an extension of time under 37 CFR 1.136(a) (PTO/SB/22) is enclosed.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

☒ attorney or agent of record. Registration number 33,744

☐ attorney or agent acting under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34. _____

Adrienne B. Naumann
Signature

Adrienne B. Naumann, Esq.
Typed or printed name

847-329-8185
Telephone number

5-5-06
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of one forms are submitted.

This collection of information is required by 37 CFR 41.31. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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1. signed and dated notice of appeal
2. Check no.3146810 for $250.00 to U.S. Commissioner of patents
3. transmittal sheet and fee sheet

Inventor and Applicant: Marvin J. Williams, Jr.; Applic. No.10/747,728; filing date: 12-29-03; Art Unit: 3643; Examiner: J.L. Gellner; Title: Improved Intercropping and Mulching Method; Attorney of record: Adrienne B. Naumann, Esq.; phone:847-329-8185; U.S. Express Mail NO. EQ471792198US

cip3mulch5intercrop.doc
12-29-03

IN THE UNITED STATES OFFICE OF PATENTS & TRADEMARKS
PATENTS

Inventor and Applicant: Marvin J. Williams, Jr.
Address: 1411 Bell Ave.
New Buffalo, Michigan 49117
Title: Improved Combined Intercropping and Mulching Method

This application is a continuation in part of U.S. utility patent application no. 10/683,889 which is a continuation in part of U.S. utility patent application no. 09/752,956, now U.S. Pat. No. 6,631,585 B1.

BACKGROUND OF THE INVENTION

(1) This application is a continuation in part of U.S. utility patent application no. 10/683,889 which is a continuation in part of U. S. utility patent application no. 09/752,956.

(2) My invention generally relates to combined intercropping of, and application of mulch to, commercial field crops. More particularly, my invention is a process in which annuals are planted in the fall to provide a green manure the following spring to intercropped commercial crops. My invention is intended for planters, farmers and gardeners of all specialties, and to all kinds, sizes and complexities of farming enterprises.

(3) 'Intercropping' is generally defined as the planting of a fast growing crop between alternating rows of a slow growing crop. My new method incorporates the commercially successful tillage system of the United States, particularly in the midwestern and prairie states. My method also incorporates the beneficial ecological effect of growing a commercial annual legume with corn, as well as incorporation of an annual green manure crop such as wheat and buckwheat.

(4) My preferred method of intercropping comprises strip cropping corn and soybeans with subsequent application of green manure to the soil, and a layer of mulch upon the top soil surface. My method does not require pesticides, herbicides or artificial fertilizers for healthy crops, or to obtain an effective ground cover and subsoil root network with an effective moisture canopy and windbreak.

(5) Moreover, my invention provides a kindlier developmental period for both soybean and corn seedlings through its microclimate effect. Annual green manure plants such as buckwheat remain uncut until tillage and seeding of the commercial crop in early spring. Green manure provides nutrients for a seedling commercial spring crop, as well as a welcome mulch ground

cover during the early growing season. My treated soil also accumulates soil nutrients with yearly use, thereby increasing land productivity. Tilling soil more than once a year may expose soil to air and decreases nutrients and fallow soil. As a result, tilling soil and leaving it without a mulch covering is discouraged.

(6) Green manure plants combined with organic residue from deceased crops contains dessicated soybean roots and nitrogen nodules which remain intact in the soil. During the winter months, the intact root systems of these nonviable soybean and corn (and viable wheat) also function as ground cover and subsoil root retention system. In this manner, intact soybean and corn roots provide a physical soil network for the no till planting of a green manure crop (for example wheat grass) in the fall or early spring as the case may be. For example, wheat grass is planted in the fall or early spring, and is subsequently tilled into the soil as green manure while green and viable.

(7) The farmer synchronizes planting (seeding) of the intercropped commercial plants with tilling the green manure plants into the soil. My process also provides: a reliable source of soluble nitrogenous and phosphorus compounds in the soil, additional humus and retention of soil, and an economical growth with cutting of green manure for a mulch covering.

(8) U.S. Pat. No. US 6,331,585 B1(Williams) discloses an intercropping method in which soybeans are seeded within corn in an alternating predetermined pattern over an entire field. This method is adjustable to other crop and legume combinations, as well as larger commercial sized operations and small home gardens and fields. For best results the corn and soybeans are seeded at the same time in early May. The corn and soybeans subsequently create a micro-climate of humidity, as well as a comprehensive root system and ground cover. These features ameliorate drought and erosion during the entire year. Another advantage is use of conservation tillage which augments ecological long term advantages of intercropping commercial annual grains and

legumes. However, no particular prior art farm implements or mulching step are provided for this intercropping method.

(9)There are prior art approaches to planting annual grain crops in a single growing area. U.S. Patent 5,140,917 (Swanson) describes a method and apparatus for seeding agricultural crops. Using this method, seeds are placed in residue free rows which are closely aligned with bands of deeply placed fertilizer. The plants from each seed are claimed to access more than one deep band of fertilizer. There is no intercropping component to Swanson's model, and Swanson requires increased fertilizer and seed costs for optimum results.

(10)European Application 0132521(Hilmer) describes intercropping with two or more crops on one piece of land per seasonal growing year. Hilmer used a grass/grain cluster/per row or a modular cluster row planter upon a slope contour.

(11) U.S. Pat. No. 4,084,522(Younger) describes a method by which soybean seeds are sown into a standing grain crop (e.g. wheat). When the grain crop is ripe, it is harvested at a height which is slightly greater than the height of the partially grown soybeans. Unlike my process, however, in Younger's model the wheat is planted first, while corn and soybeans are planted considerably later during the same growing season. Moreover, there is no specialized seed application in Younger's method.

(12) U.S. Pat. No. 6,009,955 (Tarver III) is based upon the size and shape of furrows created by a modified harvesting machine. The planter creates these furrows just prior to planting or during the planting season. The Tarver invention compresses the furrow shape just prior to or during planting, to eliminate uneven soil. Koch describes corn planted in 30-inch rows with application of insecticides and liquid nitrogen fertilizer. There is a legume ground cover such as vetch or clover. According to this report, clover did not demonstrate potential as a perennial cover crop.

Phillip Koch, "Legume Cover Crops for No-Till Corn" in J.F. Power, THE ROLE OF LEGUMES IN CONVERSATION TILLAGE SYSTEMS (1984).

(13) Decker et al. describes winter legume cover crops which were seeded after fall corn harvests, and which were allowed to grow until corn planting the following spring. His results indicated that fall-seeded legumes at least partially replace artificial nitrogen fertilizers for maximum corn yields. A.M. Decker et al., "Fall Seeded Legumes' Nitrogen Contributions to No-Till Corn Production," in J.F. Power, *supra.*

(14) Holderbaum reported results in which legumes were grown prior to corn, but later during the same growing season. In this model the legumes were clover and rye grass. According to this investigation, subsequent corn grain yields were highest when the cover crop was not removed. J.F. Hauderbaum et al.,"Forage contributions for winter legume cover crops in no-till crop production," in J.F. Power, supra.

(15) Scott and Burt reported intercropping red clover into corn seedlings when the corn seedlings were approximately six to twelve inches high. The scientists applied chemical herbicides to the seedlings during this investigation. According to Scott and Burt, they consistently obtained good crops by cultivating corn in 30- inch intercropped rows. High corn yields also consistently occurred following the plowdown of one year of red clover hay. Scott and Burt concluded that red clover or other legume establishment by intercropping into corn might become a beneficial management approach for nitrogen replenishment, organic matter addition and reduced erosion. T.W. Scott and Robert F. Burt,"Use of Red Clover in Corn Polyculture Systems," in J.F. Power, *supra.*

(16) Paudey and Pendleton reported the planting of corn seed in 1.5 meter rows with corn seedlings spaced approximately 17 centimeters apart. Three rows of soybeans were planted

between single rows of corn. The investigators applied herbicides and pesticides to the seedlings during the experiments. Forty-two days after planting, the two most exterior soybean rows were plowed into the cornrows in a traditional 'hilling up' procedure. R.K. Paudey and J.W. Pendleton, "Soybeans as a Green Manure in a Maize Intercropping System," EXPERIMENTAL AGRICULTURE 22:178-85(1986).

(17) Eadie et al. reported the effect of cereal cover crops upon weed control. The investigators hand planted cereal seed within plots which were approximately 2.3 meters wide and 8.0 meters long. The rows were approximately 0.75 meter equidistantly spaced. These investigators seeded the cereal cover crops immediately after the ridging cultivation at the 11-12 leaf stage of corn plants. According to the Eadie report, corn grain yields remained unchanged by cover crops seeded at the 11-12 leaf stage of corn, compared to bare soil treatment controls. Allan G. Eadie et al., "Integration of Cereal Cover Crops in a Ridge-Tillage Corn Production," WEED TECHNOLOGY 6 (3) (July-September 1992).

(18) Lesoing and Francis stripcropped corn and soybeans to reduce erosion in eastern Nebraska from 1988 to 1990. Corn and soybeans were no-till planted in a north-south orientation in alternating 6.1meter wide strips (eight rows, 0.76 meter between rows). Each row was approximately 46 meters in length, and each experimental planting areas comprised approximately 280 square meters. Lesoing and Francis planted corn seed at a density of approximately 66,250 seeds/ha. Between the corn strips they planted soybean seedlings in strips of eight rows at 475,000 seeds/ha.

(19) According to this study, corn border row yields next to soybeans increased significantly compared with interior rows. These scientists suggested that water stress, light quality and shading are among the factors which affect crop yields at different stages of crop development.

Gary W. Lesoing and Charles A. Francis, "Strip Intercropping Effects on Yield and Yield Components of Corn, Grain, Sorghum and Soybean," AGRONOMY J. 91: 807-13(1999).

(20)At least one farmer has reported that closer planting in rows results in more equitable distribution of sunlight, soil moisture and nutrients. NO TILL FARMER (mid-January 1986).

SUMMARY OF THE INVENTION

(21) My improved combined intercropping and mulching method includes an original approach to intercropping soybeans and corn in a conservation tillage system, but also includes other intercropping combinations of commercial crops. After blending of combined green manure and organic debris into the soil, the farmer seeds corn and soybeans simultaneously at soil temperatures of at least sixty degrees Fahrenheit (F.). The farmer then seeds the intercropped plants, and covers the seeded soil with remaining mulch made of the remaining combined chopped organic debris and green manure plants. Growing seedlings generate leaf canopies which choke weeds, thus decreasing the need for artificial chemical herbicides. Corn roots intertwine with soybean roots to generate an interwoven root system which holds soil in place.

(22) Vertical layers of the crop leaf canopy also demonstrate a shading effect on soil, thereby increasing surface moisture, eliminating sun bleaching and cracking, and lowering soil temperature. The leaf canopy has an anti-erosion effect by slowing and diverting rain and irrigation moisture through the soil.

(23) My invention also comprises the process of planting fields or gardens, in alternating rows or in other configurations, with two or more kinds of other commercial crops and legumes. In the preferred embodiment and best mode, the predetermined alternating rows and areas comprise corn and soybeans. Each crop can be in straight lines, or in curved or convoluted alignment, according to area geography.

(24) In the preferred mode and best embodiment, soybeans are spaced a predetermined distance from each other and each adjacent corn row. In other embodiments, conventional cash crops such as corn and buckwheat alternate with plants such as Queen Anne's lace, vinegar weed, Pennsylvania smartweed or cornflowers. Sweet clover and annual grass are also candidates. Other possibilities, although not exclusively, include corn and potatoes, corn and peanuts or

peanuts and soybeans. The alternating configuration of crops and other appropriate plant species also provides protection against insect pests. Insects can no longer eat from one side of a field to the other, because other selected crops become ecological barriers. Moreover, by using my new planting process, edible yields are greater for the same two dimensional or three dimensional section of a field or garden.

(25) Intercropping also comprises the growth of quick-maturing vegetable crops between slower developing crops, to maximize available garden or field space. For example, soybeans are planted in spring or summer at 2 to 3 pounds of seeds per 1,000 square feet in traditional commercial situations. Soybeans are annuals and must be re-seeded every year; however, they tolerate poor drainage well, and are ideal for nitrogen fixation. Plants such as adzuki and muny beans are fairly resistant to insect pests.

(26) My process differs from the prior art because, although soybean pods and leaves are harvested early in fall, in my process the soybean roots and nitrogen nodules are left intact in the field. These roots and nodules provide a base for a no-till planting of a green manure crop. This intact system also provides a ground cover and subsoil root retention system during the winter months and following spring planting. Green manure is typically tilled into the soil in the spring with conventional farm machinery or hand implements, as the case may be. My process also differs because growing green mature plants are harvested and stored just prior to tilling and planting. The green manure is then reapplied to the soil as mulch after planting.

(27) My improved method of planting commercial crops is synchronized with tilling and harvesting a portion of green manure which blends with field organic debris from previous crops. Green manure is dispersed through each row of corn and soybeans. The combined green manure then provides a mulch for a newly planted field. In the preferred embodiment and best mode of my method, each crop lies within straight rows, curved, or convoluted alignment, as required by

the geography of the planting area. Also in the best mode and preferred embodiment, soybeans are spaced a predetermined distance from each other and adjacent cornrows. Corn roots interact with soybean roots and nodules to a depth of approximately four feet, while soybean stems wind around cornstalks.

(28) In another embodiment and mode, alternating an appropriate third plant species protects against insect pests by mixing seed of similar sizes, such as soybeans and buckwheat. Preferably the farmer adds buckwheat seed to both corn seeds and soybean seeds just prior to planting, and as the seed drill and corn hoppers are filled with each of the two seed mixtures. Most preferably, the farmer would add approximately 10% by volume buckwheat seed to the soybean or corn seed hopper. Mixing occurs by a seed drill attachment for small seed and then alternating the third crop seeding within each 21-inch wide row with soybeans. As the buckwheat dies in midsummer, the corn and soybean roots adsorb phosphorus left by decomposing buckwheat plants. By fall when the corn and soybeans are harvested, the buckwheat grain should be absent in the fields.

(29) In other models, intercropping with a third plant species, such as Pennsylvania smartweed, is particularly beneficial because insect pests prefer smartweed to corn and soybeans. The seed drill for planting soybeans, described *infra,* can deposit two different seed sizes simultaneously in the same row (such as soybeans and smartweed).

(30) My invention also includes the use of prior art machines in new combinations, sequences and modifications. These changes decreases the labor, time, and amount of equipment required to till, simultaneously seed more than one crop in one pass, and mulch an intercropped field. By using my method with machinery in which the farmer has already invested, and with which he is familiar, the farmer finally has an incentive to intercrop his fields because there is no increased time, labor and machinery fuel and maintenance for a long-term commercial crop.

(31) Consequently, one goal of my improved intercropping method is to prevent desiccating winds from harming crops and soil.

(32) Another goal of my improved combined intercropping and mulching method is to insure that soil contains sufficient soluble nitrogenous and phosphorus compounds.

(33) Another object of my combined intercropping and mulching method is to adapt my soybean and corn embodiment to an economical model for either large-scale or more modest agricultural units.

(34) Another goal of my combined intercropping and mulching method is to add ground cover to fields which are generally uncovered and fallow.

(35) Another goal of my combined intercropping and mulching method is to decrease soil exposure to air, erosion from sun, wind and running water.

(36) Another goal of my process is to incorporate the commercial advantages of present day tillage with ecological benefits.

(37) Another goal of my process is the annual quick tilling and planting of crops to decrease nutrient loss.

(38) Another goal of my process is to eliminate sun-bleached soil.

(39) Another goal of my process is to integrate conventional farm machinery into an intercropping and mulching process which does not require additional time, labor, fuel or investment.

(40) These and other improvements will become apparent from my detailed description and drawings of my invention.

BRIEF DESCRIPTION OF THE DRAWINGS

(41) Figure 1 illustrates a lateral view of a field in late fall after harvest and cutting of commercial crops and just prior to planting wheat and buckwheat.

(42) Figure 2 illustrates a lateral view of a field in late fall after harvest of commercial crops with wheat and with buckwheat seed as a no-till planting over cornstalks and soybean stubble.

(43) Figure 3 illustrates a lateral view of a field in early spring just prior to mowing of green manure plants, corn stalks and soybean stubble.

(44) Figure 4 is a lateral view of mowed wheat grass and resulting in a twenty foot path prior to tillage, and with adjacent unmowed wheat grass.

(45) Figure 5 illustrates soil treated by a first tilling machine in a twenty-foot width with adjacent wheat grass on each side of approximately twenty-foot width.

(46) Figure 6 illustrates the soil of Figure 5 treated by a second tilling machine to a greater depth within a twenty-foot field width.

(47) Figure 7 illustrates soil of Figure 5 treated by a third tilling machine to a final greatest depth within a twenty-foot width path, and with adjacent unmowed wheat grass.

(48) Figure 8 illustrates conventionally plowed soil with non-decomposed organic debris under the soil in a single crop field.

(49) Figure 9 illustrates an anterior view of a prior art twenty-foot wide seed drill with prior art uniform horizontal distances between adjacent equidistantly spaced tru-vee openers.

(50) Figure 10 illustrates an anterior schematic view of the modified seed drill of Figure 9 with eight sets of re-aligned tru-vee openers.

(51) Figure 11 illustrates a post-tilling twenty-foot path intercropped with corn seeds and soybean seeds.

(52) Figure 12 illustrates an isolated partial lateral view of a modified seed drill.

(53) Figure 12A illustrates a schematic anterior view of tru–vee openers with fork positions and attachments.

(54) Figure 12B illustrates an isolated schematic view of the fork lift attachment and adjustment of the forks.

(55) Figure 13 illustrates a top plan schematic view of a modified seed drill moving forward over a field with a corn planter posteriorly hitched to the tractor.

(56) Figure 13A is an anterior schematic view of the modified seed drill and how tru-vee opener spacing is modified to form sets.

(57) Figure 14 illustrates a lateral isolated view of the seed drill of Figure 10 with fork lift attachment and hydraulic lifts, tractor and prior art corn planter.

(58) Figure 15A illustrates a close up isolated anterior view of fork lift attachment and modified seed drill.

(59) Figure 15B illustrates an isolated schematic posterior view of the adjustment of seed drill row cover units.

(60) Figure 16 illustrates combination mulch which covers the soil of intercropped maturing soybeans and corn.

(61)Figure 17 illustrates a cutaway perspective view for assembly of a bale chopper and forage box wagon with attached exhaust hose.

(62) Figure 18 illustrates a lateral view of a prior art forage box wagon with unload augers exposed.

(63) Figure 19 illustrates a lateral cutaway view of the assembled forage box wagon and bale chopper of Figure 17.

(64) Figure 20 illustrates a lateral view of the bale chopper and forage wagon with attached pipe, hose and bunge cords.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT, BEST MODE, AND OTHER EMBODIMENTS AND MODES

Introduction

(65) My intercropping and mulching method 110 resolves the long–felt need to intercrop economically while preserving the soil for the long term. In the best mode of my process 110, the following comprises in most basic format, without additional artificial pesticides, fertilizers and herbicides:

(i) no-till planting of green manure plants 44a during the fall within soil 45 of a predetermined area which contains organic debris 19,

(ii) harvesting a portion of the green manure plants 44a for mulch 20;

(iii) quick tilling a portion of green manure plants 44a and organic debris 19 into the soil 45 of this predetermined area the following spring, and

(iv) intercropping of commercial crops, including at least one legume, immediately thereafter within the same predetermined soil, and

(v) spreading a layer of combination mulch 20, also comprising green manure plants 44a and organic debris 19, over the surface of the intercropped seeded soil 45.

(66) Green manure plants 44a are no-till seeded during the previous fall, or spring of the following commercial planting season. The farmer next mows green manure plants 44a and plant debris 19, which becomes combination mulch 20 and is collected in a forage box wagon 51, *infra*. He then tills soil 45 with a portion of combined green manure 44 approximately nine to 14 inches deep into the same soil 45. After seeding the intercropped commercial crops, the farmer covers soil 45 containing intercropped commercial seeds with combined mulch 20. Combined mulch 20

also comprises plant debris or other organic residue 19 which remains from the fall commercial harvest (such as soybean and cornstalk stubble), along with chopped green manure plants 44a.

(67) For intercropped corn and soybeans, preferably there is approximately one (1) corn seed 10 per eight (8) linear inches of soil. This specific seeding in the best mode and preferred embodiment results in approximately five (5) mature corn plants 10c per square yard of topsoil 45a. Soybean seeds 12 are planted at approximately eight (8) to twenty (20) seeds per square foot of topsoil in the best mode. However, in other modes seed concentrations vary outside these ranges.

(68) My preferred method of combined intercropping and mulching 110 provides best results in a midwestern climate. The preferred soils are typical of southwestern lower Michigan and northern Indiana, especially Berrien County in Michigan and LaPorte County in Indiana. Crops are preferably planted in rimer loamy fine sand soils, above a river or drainage way. Soils such as rimer are easily washed away, so my combined method 101 is particularly useful in these areas. However, method 101 is also beneficial upon other farmland, as well as irrigated fields. Intercropping and green manure growth is optimal when soil 45 is planted the previous growing season with commercial soybeans 16c.

(69) The seeds for the best mode of my intercroppping and mulching method 110 are:

(1) soybean seeds 12, DeKalb variety CX303RR, Lot. No. 1744EJMLA, germ 85;

(2) corn seeds 10, DeKalb Hybrid DK 567, Lot. No. 1748JXEH, germ 95.

These preferred varieties of soybean seeds 12 and corn seeds 10 are available from:

Buchanan Feed Mill, Inc.

P.O. Box 109

Railroad Street

Buchanan, Michigan 49107-1698

(70) Other satisfactory corn seed 10 and soybean seed 12 for my improved intercropping and mulching process 110 are also available from:

Strefling Farms,

Galien, Michigan 49113

and

D & S Farms

Galien, Michigan 49113

Corn seeds 10 are R- Ready Corn®, Variety No. DK 493 R while soybean seeds 12 are 2702 ASGROW® lot number 5371EAAM, ASGROW® Variety No. AG 2702.

(71) The preferred buckwheat and wheat seed is available from:

Baroda City Mills

8923 First Street

Baroda, Michigan 49101

Lot No. BW-2001

Planting and harvesting of green manure plants 44a

(72) My preferred method 110 for an intercropped field soil 45 incorporates maturing wheat plants 17 and buckwheat 18 into combination green manure 44. The farmer begins the process 110 in late summer or early fall after harvest of an earlier commercial crop (preferably corn 10c and/or soybeans 16c) upon pre-selected soil 45. In the best mode the farmer no-till plants wheat seeds 17b and buckwheat seeds 18b in buckwheat furrows 39. These buckwheat furrows 39 are

positioned among cornstalks 5 and a three inch stubble of soybeans 16 which remain after the fall harvest.

(73) Referring initially to Figure 1, decomposed cornstalks 5 and other organic residue 19 contain droppings from Japanese beetles. Japanese beetles prefer to eat Pennsylvania smartweed instead of corn 10c and soybean plants 16, and their droppings add to organic residue 19. In other modes of method 110, the farmer plants buckwheat seed 18b over previously unplanted fallow soil 45. In these modes, the farmer intercrops buckwheat seed 18b between corn rows 8 in previously fallow soil 45. When he subsequently plants wheat 17 in the fall after mature corn 10c is harvested, there is a green manure 44 which becomes mulch 20 for a single crop of mature corn 10c or soybeans 12.

(74) Sprouting wheat 17 and buckwheat 18 promote soil 45 retention during winter. Although wheat 17 grows slowly over the winter, by spring it is well established and matures quickly, thereby preventing weeds from sprouting. Referring to Figure 2, the farmer can seed buckwheat 18b in the fall, spring or summer at (i) approximately two to three pounds of seed per 1,000 square feet, and (ii) simultaneously seeding commercial intercropped plants such as corn and soybeans. Buckwheat 18 is preferred as a green manure plant 44a, because it tolerates infertile and acidic soils but accumulates phosphorus. By adding buckwheat 18b to wheat seed 17b in the fall as a green manure plant 44a, and replanting buckwheat 18 with corn 5 and soybeans 12 in spring over previously planted wheat 17, there is additional phosphorus for soil 45.

(75) The recommended conventional no-till seeding machine 84 for wheat 17 and buckwheat 18 is a CASE 5400 no till grain drill. However, a JOHN DEERE 560 no-till drill , or a JOHN DEERE 1860 no-till air drill are also satisfactory. Referring to Figure 3, by the following spring wheat 17 and/or buckwheat 18 comprise wheat grass 18a which is approximately 14 to 20 inches in height.

(76) The CASE 5400 No-till grain drill for creating furrows 39 and seeding wheat 17 and/or buckwheat 18 is available from:

Case Canada Corporation

450 Sherman Ave.

Hamilton, Ontario L8N, 4C5 Canada

or

Case Corporation

700 State Street

Racine, Wisconsin 53404

(77) The following annuals are also satisfactory for providing combination mulch 20 and combination green manure 44 for the following spring intercropped planting:

(a) Austrian peas, which are seeded in late summer or fall in well-drained soils, and flourish in warmer climates.

(b) Hairy vetch, which is seeded in late summer or fall, with 1-2 pounds of seeds per 1,200 square feet. Hairy vetch tolerates moderate drainage, grows well in northern climates and is a good source of soluble nitrogen soil compounds.

(c) Soybeans, which are seeded in spring or summer, at 2-3 lb. of seed per 1,000 square feet. Soybeans tolerate poor drainage well.

(d) Annual rye grass which is seeded in spring at approximately one to two pounds of seed per 1,000 square feet. Annual rye grass tolerates a wide range of soils, provides a quickly placed soil

cover, and subsequently provides sufficient nutrients for a slow growing commercial crop such as fruit trees, grape vineyards, berry fields, watermelons and tomatoes.

(e) Winter rye which is seeded in late summer or fall at approximately two to three pounds of seed per 1,000 square feet. Winter rye prefers well drained soils, but it is also very winter hardy and grows well in early spring.

Production of combined green manure 44

(78) Referring to Figure 3, wheat grass 18a (consisting of the upper portions of young wheat 17 and/or buckwheat 18 plants) remains viable until it is mowed immediately prior to spring tilling. The top approximate one-half of wheat grass 18a is chopped and blended with organic debris 19 to become combined mulch 20, as explained in more detail *infra*. The remaining approximately one-half of the bottom portions of green manure plants 44 (such as wheat grass 18a), is tilled into soil 45 with organic debris 19 prior to spring seeding of intercropped commercial plants.

(79) Referring to Figure 4, in the preferred embodiment and best mode the farmer mows wheat grass 18a, residual corn stalks 5 and organic debris 19 approximately three inches to ten inches above soil 45. The determination of the exact height of mowed wheat grass 18a to properly cover soil 45 is empirical. This determination also depends upon leaf density of wheat grass 18a. Leaf density primarily depends upon nutrients in the soil, weather conditions, and time of the year, including the required 60 degrees Fahrenheit (F.) soil temperature. Consequently, each field has a different leaf density and different plant heights.

(80) Buckwheat 17 is generally mowed along with wheat grass 18a. However, buckwheat 17b can be reseeded with corn 10 and soybean seed 12 for a summer planting, to produce additional nutrients. Please see Figure 11. The recommended conventional machine for mowing wheat grass 18a, residual cornstalks 5 and residual soybean 16 stems (thereby creating combined mulch

20) is prior art INTERNATIONAL 650 Forage Harvester. This particular mowing machine comprises a cutting bar unit and is available from:

International Harvester Company
401 North Michigan Avenue
Chicago, Illinois 60611

(81) INTERNATIONAL 650 Forage Harvester mows, rakes and collects mowed green manure plants 44a and organic debris 19 for a lateral distance 101 of approximate twenty feet across a field. INTERNATIONAL 650 Forage Harvester simultaneously mows and blows upper portions of wheat grass 18a into towed forage wagon 51, for storage prior to mixing and chopping within bale chopper 108, *infra*. INTERNATIONAL 650 Forage Harvester both mows and collects wheat grass 18a for larger commercial fields, while conventional small mowing and gathering tools are satisfactory for gardens and small fields.

(82) A 5460 or 5440 Forage Harvester with mower bar unit is also satisfactory, as well as other farm machinery for cutting and collecting mowed wheat grass 18a. Forage Harvesters are self-propelled forage harvesters 50 from John Deere, Inc. With a 5460 or 5440 Forage Harvester the farmer mows an approximately 20 feet wide interval of wheat grass 18a in the first step of process 110. However, Forage Harvesters can only collect a portion of the mowed wheat grass 18a within a twenty-foot wide path, so two passes may be necessary.

(83) The farmer mows this twenty-foot wide path across the field in an east/west direction and then tills the same twenty-foot wide path prior to intercropping. Later during the growing season, sunlight falls between rows, and the tall crop (such as corn) does not shade the shorter crop (such as soybeans). After mowing and raking, in other modes the farmer deposits organic fertilizer into soil 45, such as animal manure or minerals such as lime.

Tilling of combined green manure 44 into soil 45

(84) Immediately after mowing of the first twenty-foot width 101 of wheat grass 18a, the farmer quickly tills soil 45 with organic residue 19 (such as cornstalks 5) and a three-inch stubble of remaining soybeans 16, along with a portion of wheat grass 18a. Figure 5. A preferred conventional machine 58 tilling is the 3800 series field cultivator for larger commercial fields from:

AGCO® GLENCOE®

4205 River Green Parkway

Duluth, Georgia 30096

1-800-767-3221

or

Kuhn EL 201/400

5390 East Seneca Street

Vernon, New York. 13426-0840

(85) For larger commercial fields, the most preferred power tilling machines are available from:

Kuhn Farm Machinery, Inc.

5390 East Seneca Street

Vernon, N.Y. 13476-0840

Phone: 1-315-829-2620

Models: EL35, EL50, EL80N, EL100N, and EL 140N

and are distributed by:

H.F.S. Tractor

Barode, Michigan 49101 and Niles, Michigan 49120

(86) The farmer uses a cultivator to till weeds under soil 45 between maturing commercial intercropped plants, and so the cultivator blades are shaped with different working widths than those of tilling machines. Referring to Figure 8, less preferably a plow turns soil 45 to destroy weeds, or to even and break soil 45 prior to planting commercial crops. However, a large tilling machine is more efficient than a plow, in part because tilling machines disk and level soil simultaneously.

(87) In the best mode and preferred embodiment for larger fields, a power tilling machine tills and blends soil 45 and combination green manure 44 to a depth of approximately nine (9) to fourteen (14) inches. Most preferred devices are consecutively moving power tilling machines which blend combination green manure 44 with soil 45 at a greater depth with every pass (i. e., one unidirectional trip across the pre-selected field). As seen in Figures 5, 6 and7, most preferably remaining roots 25 are tilled at a progressively greater soil depth by consecutive tilling machines.

(88) In smaller areas, a gardener uses a conventional manual garden tiller to evenly disperse combined green manure 44 throughout soil 45. In smaller areas, the gardener only tills sufficient soil 45 to plant two corn rows 8 and then deposit soybean seeds 12 within a predetermined soybean area 9 between corn rows 8. By running the conventional tiller over the same area three times, the gardener achieves the desired blended soil 45 and combined green manure 44 consistency. Rototillers for smaller fields are available from:

Troy-Bilt Rototillers

P.O. Box 368023

Cleveland, Ohio 44136

1-330-273-4550,

and are also distributed through:

H.F.S. Tractor

1218 South 11th St.

Niles, Michigan 49120

(89) For attachment to smaller tractors 97, there is the AG side shift rotating tiller from:

Celli S.p.A.

Via Zignola,2/B

47100 Forli,

Tel (0543) 754145

(90) A rototiller (for smaller areas), garden tiller (for smaller areas) or power tiller is superior to merely layering organic debris 19 with a plow. Referring again to Figure 8, a prior art plow merely cuts soil 45 and 'flips it over,' and consequently organic debris 19 may not decompose by the next spring planting season. My new method 110 uses tillers for this step, and thereby decreases fertilizer requirements. Method 110 also evenly disperses combined green manure 44 throughout the soil, thereby creating additional air spaces for new plant roots.

(91) Consecutive use of three power tilling machines also allows each attached tractor 97 to follow the other as closely as possible. Three power tilling machines can also overlap in an east/west direction for optimal sunlight. Moreover, one large power tilling machine tills an approximately thirteen feet pass width (i.e, perpendicular to direction of tractor 97 movement). By simultaneously using three tilling machines the farmer overlaps each pass for approximately a seven-foot width.

(92) A twenty-foot wide path (or pass) 101 comprises approximately eight thirty-inch wide corn rows 8, between which the farmer can plant approximately seven twenty-one inch wide alternating soybean area/rows 9 (and one row 9 extending past eighth corn row 8). However,

other crops can also be planted in this particular intercropping pattern, and/or the intercropping pattern can comprise different widths.

One-Step Seeding of Intercropped Commercial Plants

Introduction

(93) In the best mode of my invention 110, a conventional seed drill 96 is modified to plant an approximately 21-inch wide area 9 of soybean seeds 12, between linearly planted corn seed 10. The modified seed drill 96 preferably leaves alternating intervening unplanted areas 8b which are then seeded with a conventional corn planter 95.

(94) For large fields, the following machinery is preferred for seeding intercropped commercial plants immediately after tilling and blending combination green manure 44 with soil 45:

(i) General utility tractors 97 such as WHITE 6105 midsize tractors from:

AGCO® WHITE

4830 River Green Parkway

Duluth, Georgia 30136

(ii) Corn seed planters 95, such as KINZE® 3000 series planters, and which are available from:

KINZE® Manufacturing, Inc.

I-80 at Exit 216

Williamsburg, Iowa 52361-0806

(95) Other satisfactory corn seed planters 95 include SUNFLOWER® Series 9000 Grain Drills, which are available from:

Sunflower Manufacturing Co., Inc.

P.O. Box 566

#1 Sunflower Drive

Beloit, Kansas 67420

1-800-748-8481

and John Deer model NO. 1720 MaxEmerge®PLUS Planters.

(iii) Recommended seed drills 96 for soybean seeds 12 are available from:

John Deere, Inc. distributors,

and

Sunflower Manufacturing, Inc.

P. O. Box 5566

#1 Sunflower Drive

Beloit, Kansas 67420

Phone: 1-800-748-8481

Satisfactory Series 9000 grain drills 96 are also available from Sunflower Manufacturing Co., Inc. for this same purpose.

(96) In my invention each corn furrow 90 is located within a corn row 8, and two consecutive corn furrows 90 are approximately 30 inches laterally apart. However, the prior art unmodified JOHN DEERE 520 seed drill 96 of Figure 9 fails to provide separate growth areas for each crop. Referring to Figure 10, with method 110 the farmer preferably uses a modified JOHN DEERE 520 seed drill 96 for soybean seeds 12. The farmer can then sow soybean seeds 12 within an approximately twenty-one inch wide area 9 which is centrally located within a previously designated corn row 8. Each corn furrow 90 is approximately four inches deep and linearly deposited corn seeds 10 are placed approximately eight (8) inches apart.

(97) Referring to Figure 11, each soybean area 9 contains three subrow 9a, 9b, 9c, with 9b centrally located subrow within each set of three such subrows. The distance between each lateral subrow 9a, 9c (i.e., adjacent to central subrow 9b) and central subrow 9b (i.e., in the approximate

center of corn row 8) is approximately seven inches. Within a twenty foot wide path there are eight corn rows 8 with eight 21-inch wide areas 9 (each containing three subrows 9a, 9b, 9c) within seven of the eight corn rows 8. One set of three seven-inch subrows 9a, 9b, 9c extends beyond the eighth corn row 8.

Adjustment of tru-vee openers 150, 153 for seeding subrows 9a, 9b, 9c

(98) To create the seeding pattern of Figure 11, a prior art seed drill 96 such as the preferred John DEER 520 seed drill must comprise tru-vee openers 150, 152,153 and row cover units 160 .The prior art random distribution of soybean seed 12 (within an approximately 20 foot wide path) by a seed drill 96 is not a disadvantage for single crop fields. In contrast, to effectively intercrop two crops in an alternating pattern my modified seed drill 96 is adjusted to seed three subrows 9a, 9b, 9c of soybean seeds 12 within two linearly aligned corn furrows 90 during one pass. In this best mode and preferred embodiment, three consecutive subrows 9a, 9b, 9c form a single approximately 21-inch wide soybean area 9 within each consecutive 30-inch wide corn row 8.

(99) Tru–vee openers 150, 152, 153 are features of prior art JOHN DEER 520 seed drill 96. Referring to Figure 9, conventionally each such tru-vee opener 150, 152, 153 is uniformly either seven inches or ten inches from an adjacent tru-vee opener 150, 152,153 along horizontal opener draw bar 147. Each tru-vee opener 150, 152, 153 deposits soybeans seeds 12, and also comprises a posterior attached row cover unit 140 to cover each soybean subrow 9a, 9b, 9c with soil 45.

(100) Referring now to Figure 10, the preferred modified seed drill 96 is approximately twenty feet in width. The linear distance along opener draw bar 147 from right exterior edge 160a to drill center frame 149 is approximately ten feet, as is the distance between left exterior edge 160b and drill center frame 149. On either side of drill center frame 149 are four sets 151 of three tru-vee openers 150, 152, 153. Each tru-vee opener 150, 152, 153 opens soil 45 with first and second

disk blades 154a, 154b. Blades 154a, 154b are angled to each other, thereby forming a "v" with an apex at the point closest to soil 45. As tru-vee openers 150, 152, 153 move forward, blades 154a, 154b turn and cut into soil 45, creating a v-shaped indentation. A seed tube is positioned centrally between both blades to deposit seeds within each v-shaped soil indentation.

(101) As seen in Figures 12 , each tru-vee opener 150, 152, 153 within set 151 attaches to opener draw bar 147 by first and second bolts 150a, 150b respectively. In turn, bolts 150a, 150b attach to opener draw bar 147 by first, and second drill nuts 120a, 120b respectively, with first and second drill washers 130a, 130b respectively. Drill nuts 120a, 120b and washers 130a, 130b must be removed together with bolts 150a, 150b, to move each tru-vee opener 150, 153 horizontally along opener draw bar 147.

(102) As seen in Figures 10 and 12, third frame 148 lies above tru-vee openers 150, 152, 153, and comprises opener springs 170. Third frame 148 holds each opener spring 170 in place above each corresponding tru-vee opener 150,152 or 153, as the case may be. Each opener spring 170 presses downward on its corresponding tru-vee opener 150, 152, 153, thereby providing stabilization over a hard soil surface. Each opener spring 170 presses its corresponding tru-vee opener 150, 152, 153 into soil 45 in the same manner as prior art seed drills.

(103) Referring to Figures 10 and 12, each opener spring 170 also has an upper U-clamp 180 which attaches each opener spring 170 to third frame 148 with first and second nuts 150c, 150d respectively. When nuts 150c, 150d and bolts 150a, 150b are removed, a person can manually slide each tru-vee opener 150, 152, 153 horizontally along oepner draw bar 147 and third frame 148. Each tru-vee opener 150, 152, 153 also comprises a single seed tube 158 which connects each corresponding tru-vee opener 150, 152 or 153 to seed bin 159 in a manner well known in the agricultural industry.

(104) Referring now to Figures 10 and 13A, each set 151 of tru-vee openers comprises a first tru-vee opener 150 which is most interiorly positioned for each particular set 151 (i.e, first true-vee opener 150 is closest to center frame 149 within each set 151). To adjust seed drill 96 for three subrows 9a , 9b, 9c (in which first lateral subrow 9a and second lateral subrow 9c are each approximately seven inches from central subrow 9b) the farmer first removes bolts 150a, 150b, nuts 120a, 120b, 150c, 150d and washers 130a, 130b from each first tru-vee opener 150.

(105) The farmer then slides each first tru-vee opener 150 (along opener draw bar 147 and third frame 148) three inches closer to adjacent second tru-vee opener 152 (also located on opener draw bar 147). Each first tru-vee opener 150 is now approximately seven inches from the more exteriorly located adjacent tru-vee opener 152. As seen in Figure 13A, each first tru-vee opener 150 is also now closer to first or second opener draw bar exterior edge 160a, 160b respectively, as the case may be.

(106) The farmer replaces bolts 150a, 150b, with nuts 120a, 120b and washers 130a, 130b for each relocated first tru-vee opener 150. To tighten each first true-vee opener 150 in its new position, the farmer replaces bolts 150a, 150b through opener draw bar 147. He also replaces washers 130a,130b on bolts 150a, 150b, and tightens drill nuts 150c, 150d which hold each U-clamp 180 to third frame 148.

(107) Still referring to Figures 10 and 13A, second tru-vee opener 152 within each set 151 requires no adjustment and comprises the middle tru-vee opener 152 for seeding each central subrow 9b within a 21 inch wide soybean area 9. However, each third tru-vee opener 153 is most distant (within its set 151) from center frame 149. After removing bolts 150a, 150b and nuts 150c, 150d (similarly to first tru-vee openers 150), the farmer manually slides each third tru-vee opener 153 inwardly toward center frame center 149 by approximately three linear inches toward second tru-vee opener 152 within appropriate set 151. Drill nuts 120, washers 130, bolts 150a,

150b, and nuts 150c, 150d are then tightened in their new positions as with first tru-vee opener 150. First and third tru-vee openers 150, 153 within each set 151 are now each approximately seven inches apart from their corresponding central tru-vee opener 152.

Horizontal adjustment of seed drill row cover units 140

(108) Referring now to Figures 12 and 15B (posterior view of seed drilll 96), in both the prior art and my modified seed drill 96, each row cover unit 140 comprises two wheels 140a, 140b which connect to row cover unit frame 206. Each row cover unit 140 corresponds to a single tru-vee opener 150, 152 or 153 which is anterior to that row cover unit 140 (also in the prior art and my invention 110). Each row cover unit 140 also comprises a corresponding spring 170a which attaches row cover unit 140 to foot board 143.

(109) After adjusting tru-vee openers 150,153 as discussed *supra*, the farmer removes drill nuts 140c, 140d, and 140e from each corresponding row cover unit 140. The farmer now slides each row cover unit 140 directly posterior to a corresponding re-aligned tru-vee opener 150, 153 as the case may be. Each corresponding row cover unit 140 moves directly posterior to each opener 150 or 153. Drill nuts 140c, 140d, 140e are then tightened, thereby retaining each row cover unit 140 in its new horizontal position along row cover unit frame 206 and foot board 143.

(110) The farmer continues this procedure for each row cover unit 140 which corresponds to tru-vee opener 150 or 153. Tru-vee opener 152 in each set 151 within a set is not moved, so its corresponding row cover unit 140 is also left unchanged. As seen in Figure 13, this spacing avoids disturbance of corn seed 10 by placing three subrows 9a, 9b, 9c approximately midway within one 30-inch wide corn row 8.

(110) The seeding of three subrows 9a, 9b, 9c with soybean seeds 12 between consecutive corn rows 8 containing corn seed 10a, comprises the preferred embodiment and best mode of my

improved method 110. Method 110 produces a quick tilled intercropped strip in an east-west direction for optimal sun exposure, and is repeated as a one-step tilling and planting across each field as described *supra*. Three subrows 9a, 9b, 9c within consecutive 30-inch wide corn rows 8 also provides sufficient area and soil depth for both corn seed 10 and soybean seed 12 to mature, while preventing soil 45 between adjacent soybean areas 9 from remaining unplanted.

(111) If modified in the above described manner, preferred seed drill 96 does not plant over previously or posterior seeded corn rows 8, because each set 151 of tru-vee openers 150, 152, 153 leaves consecutive unplanted soil 45 for corn seed 10 between adjacent sets 151. Please see Figure 13. In sum, modified seed drill 520 seeds eight areas 9 of three soybean subrows 9a, 9b, 9c with alternating unplanted areas 8b (which are seeded by conventional corn planter 95 towed by tractor 97). Soybean seeds 12 are planted anterior to tractor 97, with one area 9 of subrows 9a, 9b, 9c always directly anterior to tractor center 97c.

(112) Other prior seed drills 96 are satisfactory for my method 110 in other modes, if they are adjustable for furrow depth and width, as well as row width. A 30-inch wide corn row 8 width comprising single straight furrows 90 results in uniform, 21-inch spacing of mature soybean plants 16 within corn row 8. Within each soybean area 9, soybean seeds 12 are planted at approximately eight (8) to twenty (20) seeds per square foot of soil 45. In other embodiments, the farmer plants with first and second tractors 97. First tractor 97 pulls JOHN DEER 520 seed drill 96, as modified *supra*, and seed drill 96 plants three subrows 9a, 9b, 9c while second tractor 97 pulls attached prior art corn planter 95. The most common prior art spacing for corn rows 8 is approximately thirty inches, but row spacing can range from approximately fifteen to forty inches.

Mounting seed drill 96 to front end loader 200 and fork lift attachment 203

(113) The above modified seed drill 96 must be operatively attached to tractor anterior 97a. In the best mode and preferred embodiment (i.e., to intercrop corn seed 10 and soybean seed 12 in one pass) the farmer equips tractor anterior 97a with a prior art front end loader 200 and prior art fork lift attachment 203.

(114) Referring to Figures 14 and 15A, front end loader 200 maintains proper alignment of modified seed drill 96 with tractor 97 and conventional corn planter 95 by connecting seed drill 96 rigidly to tractor anterior 97a through forks 202a, 202b. Front end loader 200 vertically raises and lowers this same modified seed drill 96, while seed drill 96 remains in the same rigid anterior position. Front end loader 200 and fork lift attachment 203 are centered upon tractor anterior 97a, so first horizontal side 96a of seed drill 96 is same length as second horizontal side 96b.

(115) Still referring to Figure 15A, the user mounts fork lift attachment 203 on set 151 which is immediately to the left or right of center support frame 149. In the appended figures, fork lift attachment 203 is mounted to right side 160b so that a single tru–vee opener 152 is directly anterior to tractor center 97c. In this manner the farmer can mount seed drill 96 to tractor 97 at one of two positions, as long as front end loader 200 is positioned upon one center set 151 of tru-vee openers 150, 152,153.

(116) Still referring to Figure 15A, center support frame 149 is located in the center of seed drill 96, so tractor center 97c aligns with one tru-vee opener 152. One soybean subrow 9b is now planted directly anterior to tractor center 97c. However, it is necessary to offset center frame 149 from tractor center 97c, to plant soybean subrow 9a directly anterior to tractor center 97c.

(117) Referring to Figures 12B and 15A, the farmer mounts seed drill 96 upon prior art fork lift attachment 203 by first and second attached forks 202a, 202b respectively. Forks 202a, 202b are

attached to fork lift attachment 203, while attachment 203 is attached to front end loader 200. As seen in Figure 12A, first fork 202a fully opens outward from fork lift center 203a, while second fork 202b opens half-way from forklift center 203a. As seen in Figure 12, properly positioned forks 202a, 202b lie under row cover unit frame 206 and third frame 148, but rest upon tru-vee opener frame 147.

(118) Referring to Figure 10, modified seed drill 96 comprises eight sets 151 of tru-vee openers 150, 152, 153 on each JOHN DEER 520 seed drill 96: (i) four on the first side of the tractor center 97c, one set 151 between forks 202a, 202b, see *infra*, and (ii) three sets 151on the second side of tractor center 97c. To balance seed drill 96, forks 202a, 202b each slide alongside three tru-vee openers 150, 152, 153 and center frame 149. As a result, one set 151 of tru-vee openers 150, 152, 153 fits between forks 202a, 202b after proper mounting of seed drill 96, *infra*. Please see Figures 12 and 15A.

(119) The preferred prior art front end loader 200 comprises first, second, third and fourth hydraulic cylinders 205a, 205b, 205c, 205d (generically 205) operated by an interior tractor oil pump . First and second hydraulic cylinders 205a, 205b respectively are positioned upon front end loader posterior 200b; they raise and lower front end loader 200 with fork lift attachment 203. The remaining third and fourth hydraulic cylinders 205c, 205d respectively pivot prior art retrofit adapter 206 on front end loader anterior 200a by hooks 92.

(120) Still referring to Figure 12, retrofit adapter 206 fits within slots 46a on bars 46b within prior art fork lift attachment 203; retrofit adapter 206 connects fork lift attachment 203 to front end loader 200 (not seen in this view). Retrofit adapter 206 moves with hydraulic cylinders 205c, 205d whenever fork lift 203 is mounted to retrofit adapter 206, thereby pivoting fork lift attachment 203. This arrangement of adapter 206 with hydraulic cylinders 205c, 205d and fork

lift attachment 203 allows the farmer to level seed drill 96 when seed drill 96 is attached to forks 202a, 202b.

(121) Referring now to Figures 12A and 12B, to obtain the alignment described *supra*, the farmer manually lifts first fork 202a from its initial fork slot 223a within fork lift attachment 203. He then moves fork 202a to its furthest position from fork 202b, to second fork slot 223b. He also moves fork 202b from fork slot 223c to fork slot 223d until it is approximately 30 inches from fork 202a. Fork 202a slides to its fully opened 24 inch length, while second fork 202b opens only half-open twelve inches from fork lift attachment center 203a.

(122) First fork 202a extends further than second fork 202b, because fork 202a slides adjacent to frame 149, and so it moves further than fork 202b from its original position. Each fork 202a, 202b moves approximately 24 inches for an approximately 48-inch horizontal interval with forks 202a, 202b fully open. Thirty inches is the horizontal interval necessary to fit tru-vee openers 150, 152, 153 and center frame 149 between forks 202a, 202b. Please see Figure 13. The half open position of fork 202b is approximately (i) ten inches from fork lift center 203a, (ii) ten inches from the exterior edge 203b of fork lift attachment 203; and (iii) thirty-four inches from exterior edge 203c. These measurements take into account that forks 202a, 202b are each approximately four inches wide and approximately 1¼ inches thick.

(123) Prior to mounting seed drill 96 to fork lift 203, fork 202a must slide alongside center frame 149 on seed drill side 96a. As seen in Figure 15A one set 151 of tru-vee openers 150, 152, 153 respectively fits between forks 202a, 202b. The farmer then attaches forks 202a, 202b to opener draw bar 147 with first and second U-clamps 208a, 208b respectively. Prior art unmodified seed drill 96 only deposits one row of soybean seeds 12 to the left and right of tractor center 97c. However, as seen in Figure 15A, in my invention 110 there are four sets 151 of three tru-vee openers 150, 152, 153 on either side of center support frame 149. Now the farmer can attach

modified seed drill 96 to fork lift 203, so one tru-vee opener 152 directly anterior to tractor center 97c.

(124) To mount seed drill 96 to fork lift 203, the farmers lifts hydraulic cylinder 205b, which is located beneath and at the posterior of front end loader 200. He then lifts front end loader 200 until each fork 202a, 202b moves under row cover unit frame 206. The farmer pivots hydraulic cylinder 205a (located upon and anterior to front end loader 200) to level forks 202a, 202b so forks 202a, 202b can slide between third frame 148 and opener drawer bar 147. Forks 202a, 202b must be completely level, otherwise forks 202a, 202b will not slide between third frame 148 and opener drawer bar 147.

(125) The farmer next drives tractor 97 forward to further slide forks 202a, 202b under third frame 148 and upon opener draw bar 147. Fork 202a slides alongside center frame 149 on first seed drill side 96a while fork 202b slides alongside tru-vee opener 153 on second seed drill side 96b. One set 151 of three tru-vee openers 150, 152, 153 are now located between fork 202b and center support frame 149.

(126) The farmer now places first and second ten inch U-clamp 208a, 208b respectively upon each fork 202a, 202b respectively, as well as upon opener draw bar 147. He then tightens U-clamp nuts 42 with first and second U-clamp steel plates 41a, 41b between U-clamp nuts 42 and opener draw bar 147. Using hydraulic lift 205b (located upon posterior 203b of fork lift attachment 203) the farmer lowers seed drill 96 to disperse soybean seeds 12. He elevates seed drill 96 at the end of a soybean area 9 or when otherwise transporting seed drill 96.

(127) A John Deere 541 Series Loader 200 with attached fork lift 203 is the preferred front end loader and forklift of choice. However other front end loaders 200 and fork lifts 203 are satisfactory, depending upon compatibility with a farmer's equipment. As seen in Figure 13, front

end loader 200 pushes seed drill 96 while corn planter 95 follows behind tractor 97 and linearly deposits corn 10 within corn furrows 90. Referring to Figure 14, in the best mode the farmer attaches corn planter 95 to tractor 97 posterior, using a three point hitch 230a or a one point tug hitch 230b, both of which are familiar to the agricultural industry.

(128) With a conventional front end loader 200 and a coupled conventional fork lift 203, a farmer intercrops at least two plants simultaneously, thereby saving time, machine fuel and labor. In other modes modified seed drill 96 is towed by a first tractor 97 with attached corn planter 95, and which closely follows modified seed drill 96. Whether seed drill 96 or corn planter 95 proceeds the other is not crucial, if no significant time passes between corn and soybean seedings.

Attached corn planter 95

(129) Referring to Figure 11, the farmer plants corn seeds 10 linearly within furrows 90 with a prior art mechanical corn planter 95 (preferably a KINZIE 3100 corn planter). Each corn planter 95 has row units 162 which open soil to create corresponding corn furrows 90. Each row unit 162 also places corn seed 10 within its corresponding corn furrow 90. As corn planter 95 moves forward, each corresponding row cover unit 162a covers its furrow 90 with soil 45.

(130) Referring to Figure 14, there are eight row units 162 (not all seen in this view) which horizontally align upon prior art corn planter 95, with corn planter 95 posteriorly attached to tractor 97. Each row unit 162 mechanically opens each furrow 90 and deposits corn seed 10a. Corn planter row units 162 are adjustable for linear intervals of seed deposit location, as well as seeding to a pre-determined depth. With my method 110, each row unit 162 deposits a corn seed 10a every eight linear inches, while row cover unit 162a then covers seeds 10 with soil 45.

(131) After the farmer has intercropped and applied combination mulch 20 (described *infra*) to the first twenty-foot wide area of soil 45, he tills soil 45 and combination green manure 44 for an

additional eight corn rows 8 (i.e, another approximate twenty feet lateral width) adjacent to the preceding intercropped twenty-foot wide area. This incremental process continues for each twenty-foot wide pass comprising eight consecutive furrows 90 which are separated by 30-inch corn row 8. In the best mode the operator uses a JOHN DEERE 520 seed drill 96 with a twenty-foot plant path width, and an unmodified prior art corn planter 95 with an approximate twenty-foot pass width. However, if the operator uses a four row corn planter 95, he only tills that much soil 45 within four corn rows 8 of one pass.

(132) Other means of intercropping commercial plants are also within the scope of my invention for larger commercial fields. For small gardens, the farmer uses a conventional manual leaf rake 99 to distribute soybean seed 12 randomly within each approximately twenty- inch wide soybean area 9. With either the manual method or mechanized approach, soybean seeds 12 are planted approximately two to three inches deep into soil 45.

Production and Application of Combination Mulch 20

Introduction

(133) In the best mode mowed green manure plants 44a, corn stalks 5 and other organic debris 19 remaining after the fall harvest are collected similarly to conventional forage: A forage feed harvester harvests and blows mowed green manure plants 44a and debris 19 into forage wagon 51. Please see Figure 18. In my invention 110, initial blending of combination mulch 20 results from mowing and blowing of severed green manure plants 44a and debris 19 into forage wagon 51.

(134) Prior art bale chopper 108 chops organic debris 19 over soil 45, along with corn stalks 5, soybean stems and mowed green manure plants 44a (preferably wheat grass 18a) as combination mulch 20. Several seconds is the ideal maximum time interval between procedures for seeding

and mulching during method 110. However, a time interval of no more than approximately two hours between seeding and mulching a twenty foot pass width is satisfactory.

(135) Referring now to Figures 17 and 19, the GOOSEN bale chopper is the preferred bale chopper 108, and it is available from:

Goosen Industries

P.O. Box 705

Beatrice, Nebraska 68310

1-800-228-6542;

1-402-228-4226

(136) The preferred prior art forage box wagons 51 for temporarily storing large amounts of combined chopped mowed wheat grass 18a and organic debris 19 is available from:

H&S Manufacturing Co.,Inc.

2608 South Hume Avenue

P.O. Box 768

Telephone: 1-715-387-3414

Marshfield, Wisconsin 54449

Models: HD7+4 & HD Twin Auger;

HD7+4 HDTwin Auger-front and rear unload; and

power box-rear unload

(137) For smaller amounts of wheat grass 18a and organic debris 19, preferred Versa Vac storage box

wagons (conventionally used for grass clippings and leaf pick-up) are available from:

Fuerst Brothers, Inc.

P.O. Box 427

Gibson City, Il.

1-800-435-9630,

Models: M180G,M500P,M500G,M900P,M900G.

Fuerst Manure Spreaders are also satisfactory and are distributed by:

H.F.S. Tractor

1218 South 11th Street

Niles, Michigan

1-616-683-7272

(138) Unload augers 215a, 215b and discharge opening 137 comprise a cover or lid in the prior art. Attachment of conventional forage box wagons 51 to forage harvesters is already routine for harvest and storage of forage feed. However, my method 110 introduces a new manner to produce combined mulch 20 from green manure 44 and organic debris 19 in forage box wagon 51. In this process, the farmer operatively attaches bale chopper 108 to the side of forage box wagon 51 around first and second unload augers 215a, 215b respectively, *infra*. My method 110 eliminates manual labor for filling bale chopper 108 in the prior art. In addition, my remounted pipe 230a and hose 230b spray combination mulch 20 over the intercropped seeded field in a manner well known in this agricultural industry. Please see Figure 16.

Mounting bale chopper 108 and extension hose 203 to forage box wage 51

(139) Prior to intercropping the farmer attaches preferred gasoline powered prior art bale chopper 108 to forage box wagon 51. First and second unload augers 215a, 215b respectively are located within discharge opening 137 along the anterior lateral exterior surface of forage box wagon 51. Please see Figures 17, 18. On either side of each first

and second unload auger 215a, 215b are rear extension panel st17 and anterior extension panel st18 respectively. Power take off (PTO) 165 is a prior art drive shaft at tractor posterior 97e which connects to a second drive shaft on forage wagon 51. When functionally connected, PTO 165 transfers power from tractor 97 to forage wagon 51 to operate both unload augers 215a, 215b.

(140) In my invention 110, organic debris 19 and green manure plants 44a are pulled from prior art forage wagon 51, through rotating augers 215a, 215b and beaters 36 located above augers 215a, 215b. Using prior art t-rod slats attached to chains (not seen) on the floor of forage wagon 51, green manure 44 is pulled to the forage wagon anterior. Rotating unload augers 215a, 215b propel debris 19 and green manure plants 44a through discharge opening 137 into bale chopper 108, while plastic guard 169 protects the farmer from injury during operation.

(141) Referring now to Figure 19, unload augers 215a, 215b do not physically connect to bale chopper 108 in any manner. Instead, blended debris 19 and green manure plants 44a move through discharge opening 137 around augers 215a, 215b and then into bale tube 76, prior to entering bale chopper main frame 130. Bale tube 76 holds organic debris 19 and green manure plants 44a, until main frame knife blades 175a rotate and chop debris 19 and plants 44a, thereby creating combination mulch 20.

(142) As best seen in Figure 17, front and posterior panels st17, st18 respectively form first and second parallel walls of discharge opening 137. To attach bale chopper 108 to discharge opening 147, the farmer slides bale chopper 108 along panel st17, st18 exterior surfaces until interior surfaces of bale tube 76 snugly fit over exterior surfaces of panes st17, st18. The farmer next drills two ½ inch diameter circular apertures 240a, 240b (using a conventional power drill and a ½ inch drill bit) through anterior edges 17a, 18a of each corresponding extension panel st17, st18.

Each pair of apertures 240a, 240b is located approximately four inches above the bottom of either extension panel st17, st18. He also drills similar apertures 241a, 241b through both posterior edges 76a, 76b of bale tube 76.

(143) The farmer then places a first two–inch long by ½ inch thick auger bolts 225a through apertures 240a, 241a and an identical second bolt 225b through 240b, 241b respectively. He then tightens auger bolts 225a, 225b in place by prior art washers and nuts (not seen). In this manner, he attaches bale chopper 108 to each front and rear extension panel st18, rear st17 with first and second auger bolts 225a, 225b (i.e., two auger bolts 225 along each corresponding anterior edge 18a, 17a respectively of each front extension panel st18 and rear extension panel st17 respectively)

(144) Still referring to Figures 17, 19 and 20, the farmer attaches one first and one second main frame L-bracket 220a, 220b respectively to first side stack st8 and second side stack st9 respectively. There are at least four self-taping screws 242 for attachment of each L-bracket 220a, 220b to side stack st8 and side stack st9. Each L-bracket 220a, 220b is preferably twelve-inches in length by one inch in width, and each self-taping screw 242 is approximately 3/8 inch wide by ½ inch–long. L-brackets 220a, 220b attach to both bale chopper main frame 130 and the side of forage box wagon 51 with bale chopper 108.

(145) As seen in Figures 17 and 19, the farmer must elevate bail chopper 108 so that bale tube 76 snugly encloses front and posterior panels st17, st18 prior to bolt 225a, 225b and L-bracket placement 220a, 220b. Because this bolt and bracket placement requires several hours, a platform for mounting bale chopper 108 is recommended. Preferably, the farmer places bale chopper 108 upon two wood blocks 109a, 109b until bale chopper 108 is attached by brackets 220a, 220b and bolts 225a, 225b to forage wagon 51.

Attachment of hose 230b and spray of combination mulch 20

(146) Referring to Figures 19 and 20, the farmer uses four conventional bunge straps 229 to physically attach exhaust hose 230b, by hooking bunge straps 229 to first and second side stacks st7, st8 respectively, as well as third and four side stacks st10,st11 along forage wagon 51. Pipe 230a connects bale chopper 108 to hose 230b in a manner well know in this art. Preferably hose 203b is trimmed to spray combination mulch 20 over soil. 45.

(147) In smaller fields or gardens, implements such as the 109 BLUEBIRD™ EasyRake to collect and preferably distribute a smaller quantity of combination mulch 20 over soil 45. The farmer then manually plants and seeds soil 45 within an area of approximately ten to 20 feet in width. The farmer can then follow seeding with application of combination mulch 20 in the smaller field or garden.

(148) The BLUEBIRD™ EasyRake is available from:

BlueBird International, Inc.

1400 East 66th Avenue

Denver, Colorado 80229 U.S.A.

Phone: 1-303-288-5880; 1-800-808-BIRD

Timetable and schedule for planting

(149) The best mode and preferred embodiment for the spring planting schedule for my combined intercropping and mulching method 110 is as follows:

(a) During early May, the planter checks soil 45 to ensure a minimum soil temperature of 60 degrees F. Also at this time, the planter checks soil nutrients, by using a soil test kit well known in the industry. Such a kit is Rapitest Soil Test Kit No. 1601, which is available from:

Luster Leaf Products, Inc.

2220 Techcourt

Woodstock Il. 60098

Phone: 1-800-327-5567

(150) (b) Also early in May of the same growing season, green manure plants 44a and organic crop debris 19 are mowed and raked. One portion of combined green manure 44(i.e, green manure plants and organic crop debris 19)is briefly stored for combination mulch 20, as described supra. In the best mode wheat grass 18a and/or buckwheat 17 comprising green manure 44 are cut approximately three to ten inches above soil 45.

(i) approximately one/half of combination green manure 44 and organic residue 19 is tilled approximately four inches into soil 45.

(ii) the farmer then tills soil 45 and organic residue 19 to a depth of approximately nine to 14 inches in large commercial fields and approximately four to nine inches in depth in a garden. He then immediately seeds corn 10 and soybeans 12, covers them with soil 45, and lastly covers the soil with combination mulch 20 to approximately 1/2 inch in depth.

(151) Combination mulch 20 diminishes soil heat loss and also absorbs solar warmth at this point in the growing cycle when the air temperature is still cool. There is also heat created by bacterial and fungal decomposition of combined green manure 44 within soil 45, as well as diminished sun-bleached soil.

(152) (c) First week after seeding and mulching: Corn seedlings 10b and soybean seedlings 14 sprout, due to increase in moisture and heat from combination mulch 20. There is also solar heat from combination mulch 20 and retention of moist heat from above surface combination mulch 20.

(153) (d) Second week after seeding: Corn seedlings 10b and soybean seedlings 14 compete for space and create a leaf canopy 30. Nitrogen fixing soybean root nodules 18 first appear.

(154) (e) Third week after seeding: Maturing corn plants 10c are approximately 14 inches in height. Soybean corn leaf canopy 30 begins to shade soil 45, thus discouraging sprouting weeds 62. Most soybean root nodules 18 now are clearly visible.

(155) (g) Fourth week after seeding: Maturing corn plants 10c are now approximately 30 inches in height and maturing soybean plants 16 are approximately 23 inches in height. Weeds 62 continue to weaken from light deprivation. Soybean and corn plants 10c, 16 respectively quickly fill space with available sunlight.

(156) (h) Sixth week after seeding: Corn roots 25 now physically contact soybean roots 17. Corn plants 10c turn from a glossy light green to a darker green color, while corn roots 25 continue to elongate and contact soybean roots 17. Soybean pods 18 appear in approximately mid-July.

(157) (i) Seventh week after seeding: Corn roots 25 continue to elongate towards soybean roots 17. Both soybean roots 17 and corn roots 25 intertwine to form a physically massive root system 25a. Meanwhile, leaf canopy 30 assists in retention of moisture within soil 45. Leaf canopy 30 also prevents the sun from cracking and bleaching topsoil 45a.

(158) (j) Eighth week after seeding: Sporadic weeds 62 grow through corn and soybean leaf canopy 30. However, they generally remain stunted and close to topsoil 45a. Surviving smartweed diminishes Japanese beetle consumption of maturing soybean plants 16 and maturing corn plants 10c.

(159) Planted in the above manner and according to the above timetable/schedule, maturing corn plants 10c and soybean plants 16 more effectively resist near-drought conditions with a topsoil temperature of approximately 80 degrees (Fahrenheit) F. Intertwining root system 25a retains moisture by reducing evaporation and erosion.

(160) Unlike my mulch treated intercropped topsoil 45a, topsoil of conventional single crop fields generally acquires an approximate 1/8 inch sun bleached crust during summer months. Moreover, conventional single crop fields remain desiccated from approximately one to three inches into soil 45 by August during typically dry midwestern summers. In fact, summer soil temperatures in these single crop fields routinely reach a temperature of at least approximately 100 degrees F.

(161) My intertwining root system 25a, even after an early frost, remains physically intact and retains soil and nutrients during winter months. Intertwining root system 25a also resists erosion from wind, snow and rain, thereby preventing soil losses of bare conventional winter fields. Hundreds of corn roots 25 and soybean roots 25 demonstrate intertwining root systems 25a, and reveal more roots 25 on the side of corn plants 10c which are physically closest to soybean plants 16. Moreover, corn plant roots 25 are longer on sides closest to soybean plants 16. Corn plant roots 25 also quickly attach to organic debris 19 tilled into soil.

Windbreaking and microclimate 31

(162) Each intercropped corn row 8 comprising linearly aligned corn plants 5 exhibits a windbreaking effect on shorter proximate soybean plants 16 (from approximately the first two feet of maturing soybean plant 16 height). Each intercropped row/area 9 of soybean plants 16 also has its own windbreaking effect on lower cornstalks 5. All these windbreaking effects prevent wind from desiccating and blowing topsoil 45a.

(163) Examples of conventional windbreaks include a fence of appropriate height and permeability, as well as treelines. These windbreaks should be approximately 50 percent permeable and have a windbreaking effect up to six times the height of the particular plant. A permeable fence allows at least 50% of prevailing wind to pass through of its structure, and consequently it slows and does not stop the wind. My combined intercropping and mulching

process 101 differs from artificial windbreaks, because each corn row 8 is itself an effective windbreak feature. In fact, each linear arrangement of corn within its corn row 8 exhibits a windbreaking effect on crops of approximately six times the height of an average corn plant 10c. However, corn plants 10c must be planted linearly as in corn rows 8, and they must be intercropped with plants such as soybeans 16 or buckwheat 18.

Moisture Retention

(164) Corn leaves 19 are physically shaped as moisture collectors, as are soybean leaves 26. Corn leaves 19 collect water drops which flow to lower soybean leaves. Or, moisture such as rain or dew collecting within corn leaves 19 gutters to leaf pockets and then directly to topsoil 45. Soybean leaves 26 recollect water dropped from corn leaves 19 and gutter to topsoil 45a in a similar manner. This moisture collection aids artificial irrigation by forming tiny streams which drain directly to the soil lying beneath leaf canopy 20. This process occurs shortly after soybean seeds 12 and corn seeds 10 sprout approximately two weeks after seeding. By the third week after seeding (planting), there is a full effect before the summer growing, when water generally becomes more scarce, particular in treeless fields.

(165) Microclimate 31 of my combined intercropping and mulching process 110 also creates, between topsoil 45a and leaf canopy 30, a zone of diminished air movement and low light intensity. Artificial fertilizers are unnecessary in this best mode and preferred embodiment of my combined mulching and intercropping process 110. However, in other embodiments the planter can apply fertilizer uniformly throughout the soil to a depth of approximately eight inches, in a concentric manner around each row 8, 9 of plants 10c, 16.

Harvesting the commercial crop

(166) Mature soybean pods 20 are harvested during October or November, which is after corn ears are harvested, and the soybean pods 20 attain sufficient moisture. Subsequently, corn ears

continue to dry in the field. In late October or early November, corn ears are harvested by a conventional combine, which is well known in the agricultural industry.

(167) As seen *supra,* my improved combined intercropping and mulch process 110 allows corn harvests with different crop combinations. However the drying times of different crop species varies, as does crop and weather moisture content between growing seasons. Therefore, the planter should make an individualized decision each year, as to exactly when to harvest the commercial corn and soybean crops. Such re-evaluation diminishes losses from leaving crops in the field an overly long time.

(168) My improved intercropping and mulching method 110 seeds at least two commercial crops simultaneously. The time interval for maturation of both corn 10a and soybeans 12 is approximately one hundred days. My generic method requires that soil 45 be tilled evenly and blended with combined green manure 44. In addition, legumes are a requirement for all my intercropped fields as at least one commercial crop.

CLAIMS

Claim 1: An improved intercropping and mulching method, said improved intercropping and mulching method comprising:

(1) planting an annual green manure crop in the soil of a predetermined area;

(2) harvesting said annual green manure crop the following spring, said annual green manure crop being combined with organic residue to form combined green manure, said combined green manure comprising a first portion and a second portion, said second portion of said combined green manure further blended with said soil of said predetermined area, said first portion becoming a combination mulch,

(3) intercropping at least two commercial crops within said soil blended with said combined green manure,

(4) thereafter dispersing said first portion of said combined mulch upon said soil of said predetermined area, said predetermined area now containing seeds of said first commercial crop and second commercial crop,

whereby, said combined green manure provides nutrients to said commercial crops and said combination mulch provides a ground cover and nutrients for said intercropped commercial crops, said green manure crop and organic debris protecting said soil of said predetermined area during the winter.

Claim 2. The improved intercropping and mulching method as described in Claim 1, wherein said first intercropped commercial crop comprises a legume.

Claim 3. The improved intercropping and mulching method as described in Claim 1, wherein said first intercropped commercial crop comprises soybeans.

Claim 4. The improved intercropping and mulching method of Claim 1 wherein one said intercropped commercial crop comprises corn.

Claim 5: The improved intercropping and mulching method of Claim 1 wherein two said commercial crops comprise corn and soybeans.

Claim 6: The improved intercropping and mulching method as described in Claim 1, wherein there are no intercropped plants other than a first and second intercropped commercial plants, said first and second intercropped commercial plants comprising corn and soybeans.

Claim 7: The improved intercropping and mulching method as described in Claim 6 wherein said corn and said soybeans are planted in an alternating patterns comprising soybean areas and corn rows, each area and row comprising a predetermined lateral width.

Claim 8. The improved intercropping and mulching method as described in Claim 7, wherein said green manure crop comprises buckwheat.

Claim 9. The improved intercropping and mulching method as described in Claim 1, wherein said legume commercial crop is from the group consisting of Austrian peas, hairy vetch, red clover, soybeans, annual rye grass, and winter rye, and said green manure crop comprises buckwheat and wheat.

Claim 10. The improved intercropping and mulching method as described in Claim 7, wherein said green manure crops are mowed with a conventional mechanical forage harvester.

Claim 11. The improved intercropping and mulching method as described in Claim 1 wherein said combination green manure is sprayed upon said soil of said predetermined area after blending and chopping of said green manure plants and organic debris within a conventional bale chopper.

Claim 12. The improved intercropping and mulching method as described in Claim 6 wherein said intercropped soybeans are planted simultaneously with said intercropped corn by using a fork lift attachment with two forks, front end loader and tractor, conventional corn planter, and a modified conventional seed drill, said modified seed drill and said fork lift attachment to said tractor by said front end loader, said for lift attachment elevated with a hydraulic lift and a retrofit adapter.

Claim 13. The improved intercropping and mulching method as described in Claim 12 wherein said conventional corn planter deposits corn seeds between previously planted soybean areas, said soybean areas consisting of soybean subrows, said soybean subrows deposited by said modified seed drill attached to said prior art tractor, said corn seeds deposited within straight corn furrows.

Claim 14: An improved intercropping and mulching method for corn and soybeans, said method comprising:

(A) Planting a commercial legume crop in the soil of a predetermined area during the summer, said commercial legume crop forming organic debris within said soil after harvesting of said commercial legume crop,

(B) No-till planting buckwheat and wheat during the fall in said soil of said predetermined area, said buckwheat and wheat growing until the following spring, said buckwheat and wheat covering said soil during the winter,

(C) Mowing and tilling said buckwheat and wheat within said soil during said following spring, said mowing and blending accomplished by using a conventional forage harvester and a conventional tilling machine, a first portion of said buckwheat and wheat forming a green manure for said soil of said predetermined area, a second portion of said buckwheat and wheat forming a mulch for said soil after intercropping of said commercial crops,

(D) creation of corn rows, each said corn row comprising three subrows of soybean seeds, and seeding said soybeans in alternating areas between consecutive corn rows by using a modified conventional seed drill, a fork lift and a front loader;

said modified conventional seed drill comprising sets of tru-vee openers along an opener draw bar and a third frame, said tru-vee openers comprising seed tubes, each said true vee opener further comprising an opener spring, said fork lift attached to said seed drill by a first and second fork, said forks attaching to said seed drill by enclosing one set of tru-vee openers, said seed drill so aligned with said tractor so that said soybean seeds are deposited directly beneath and anterior to the tractor center,

(E) seeding said corn seed with a conventional corn planter attached posterior to said tractor, said corn planter creating corn furrows within said soil for planting of corn, said corn furrows containing linearly deposited corn seeds, said corn furrows spaced laterally from each other approximately 30 inches, said soybean subrows located between said corn furrows.

(F) covering said seeded soil with combination mulch, said conventional bale chopper chopping said green manure plants and organic debris to create said combination mulch, said green manure plants and organic debris within a forage wagon spun into unload augers prior to

chopping within said bale chopper, said mulch sprayed onto said soil of said predetermined area with a hose attached to a conventional bale chopper mounted to a forage box wagon.

ABSTRACT

A method of combined intercropping and mulching of commercial crops is described herein. A suitable annual such as buckwheat is planted in soil in which legumes were originally planted. A portion of the resulting wheat grass is mowed and blended with organic debris to provide nutrients for intercropped commercial plants such as corn and soybeans. The remaining portion is chopped blended with organic debris and sprayed onto the top layer of seeded soil as combination mulch. For larger commercial applications, conventional agricultural machines are described herein, and are modified for the most efficient intercropping. For best results, at least one intercropped commercial plant should be a legume.

Respectively submitted,

Adrienne B. Naumann, Esq.
Attorney of Record
Reg. No. 33,744
Phone: 847-329-8185
Facsimile: 847-329-8750

For Marvin J. Williams, Jr.
Inventor and Applicant

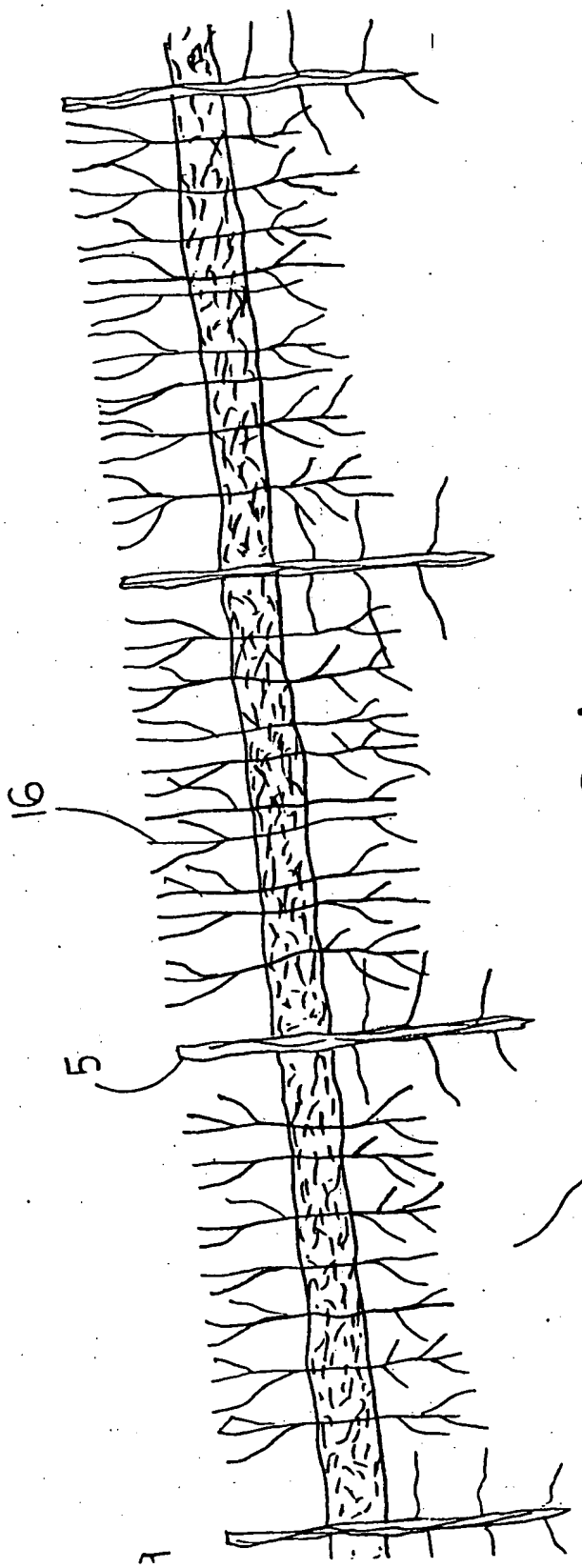


FIG. 1

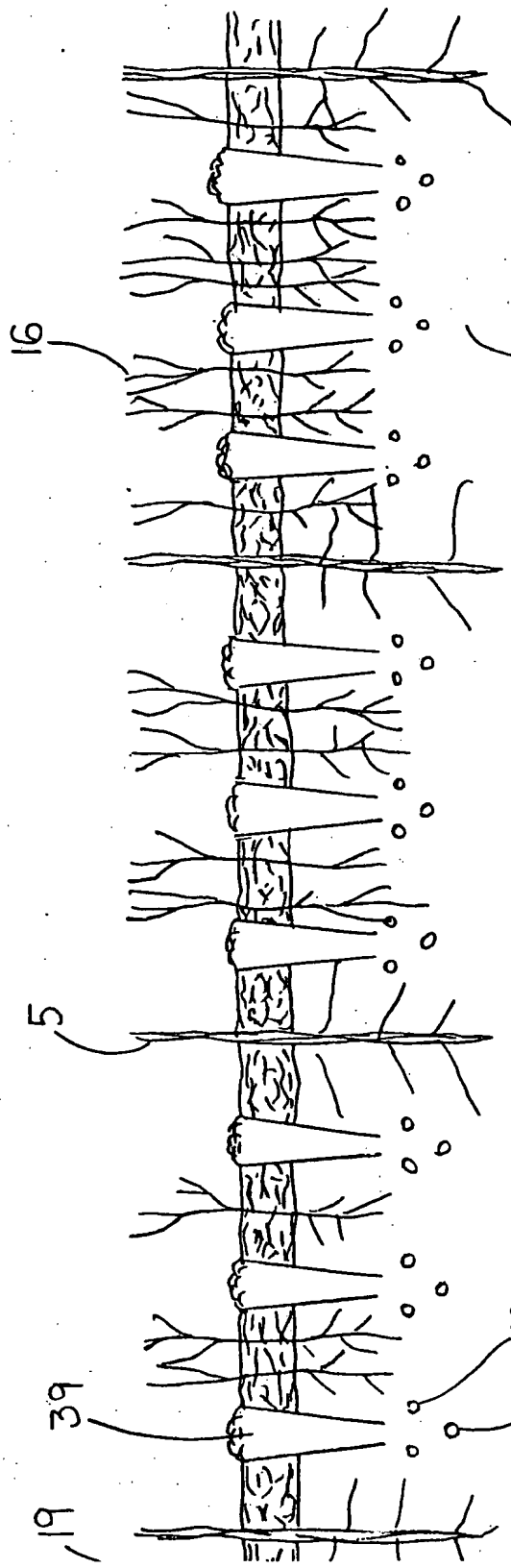


FIG 2

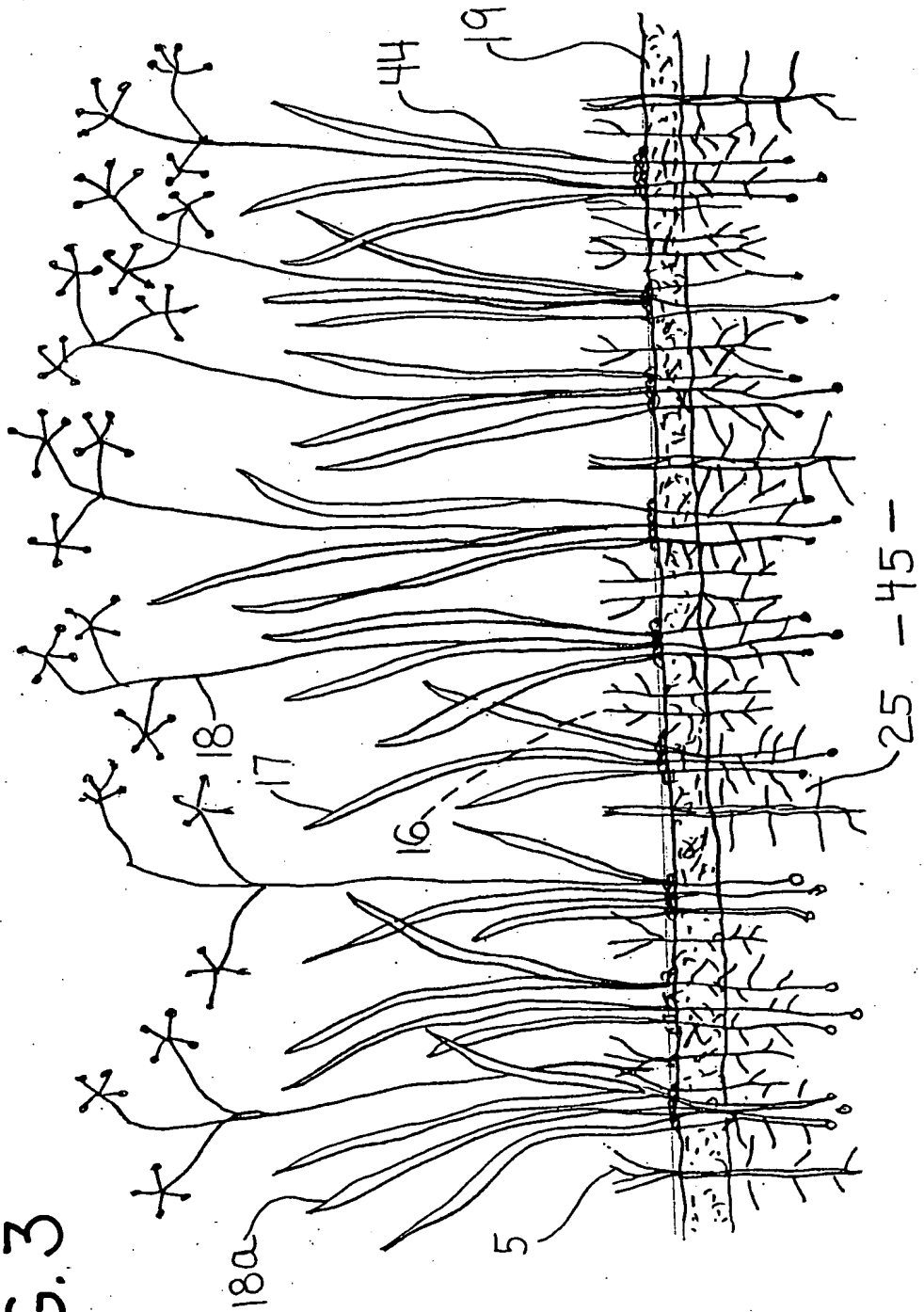


FIG. 3

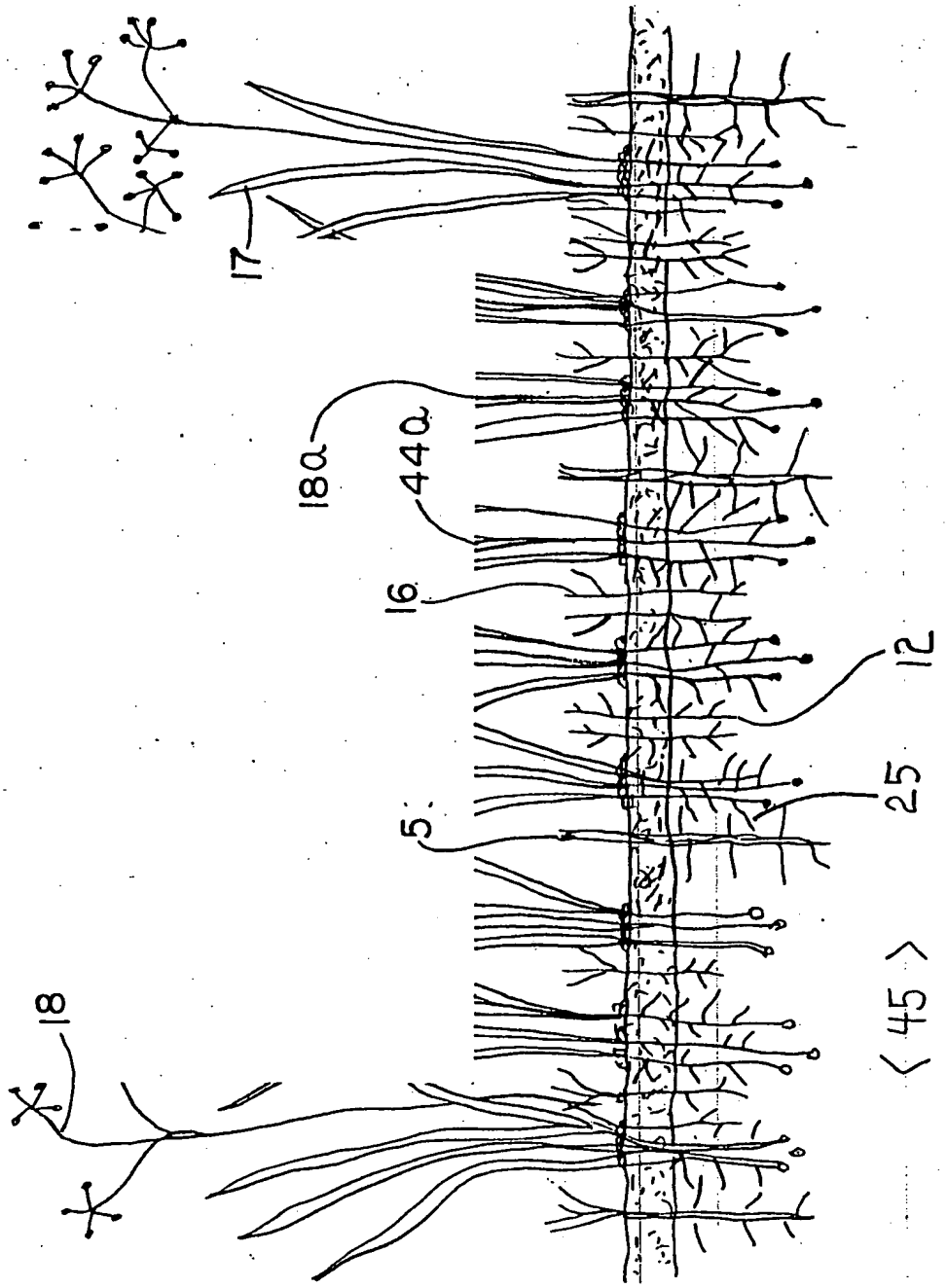


FIG.4

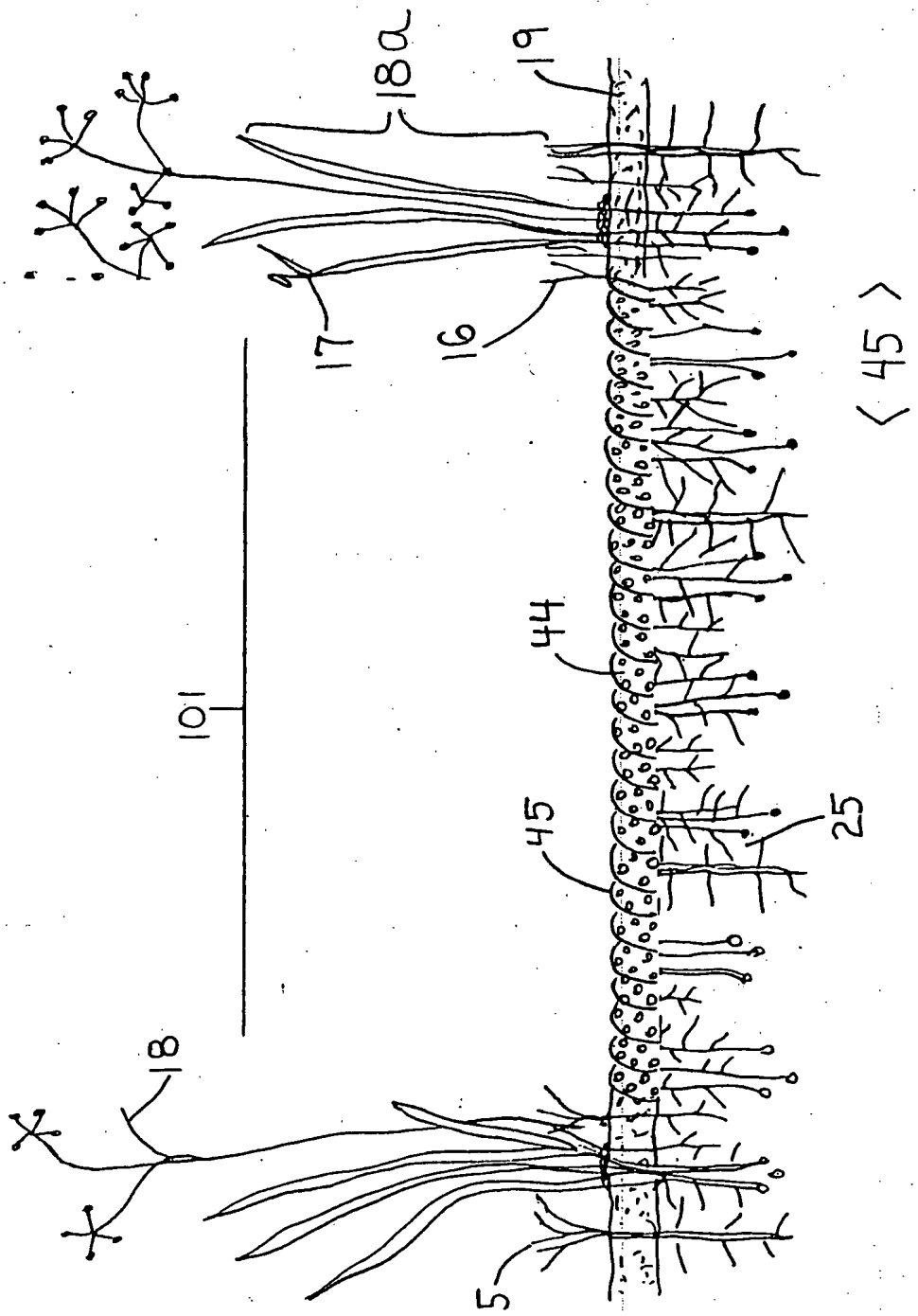


FIG. 5

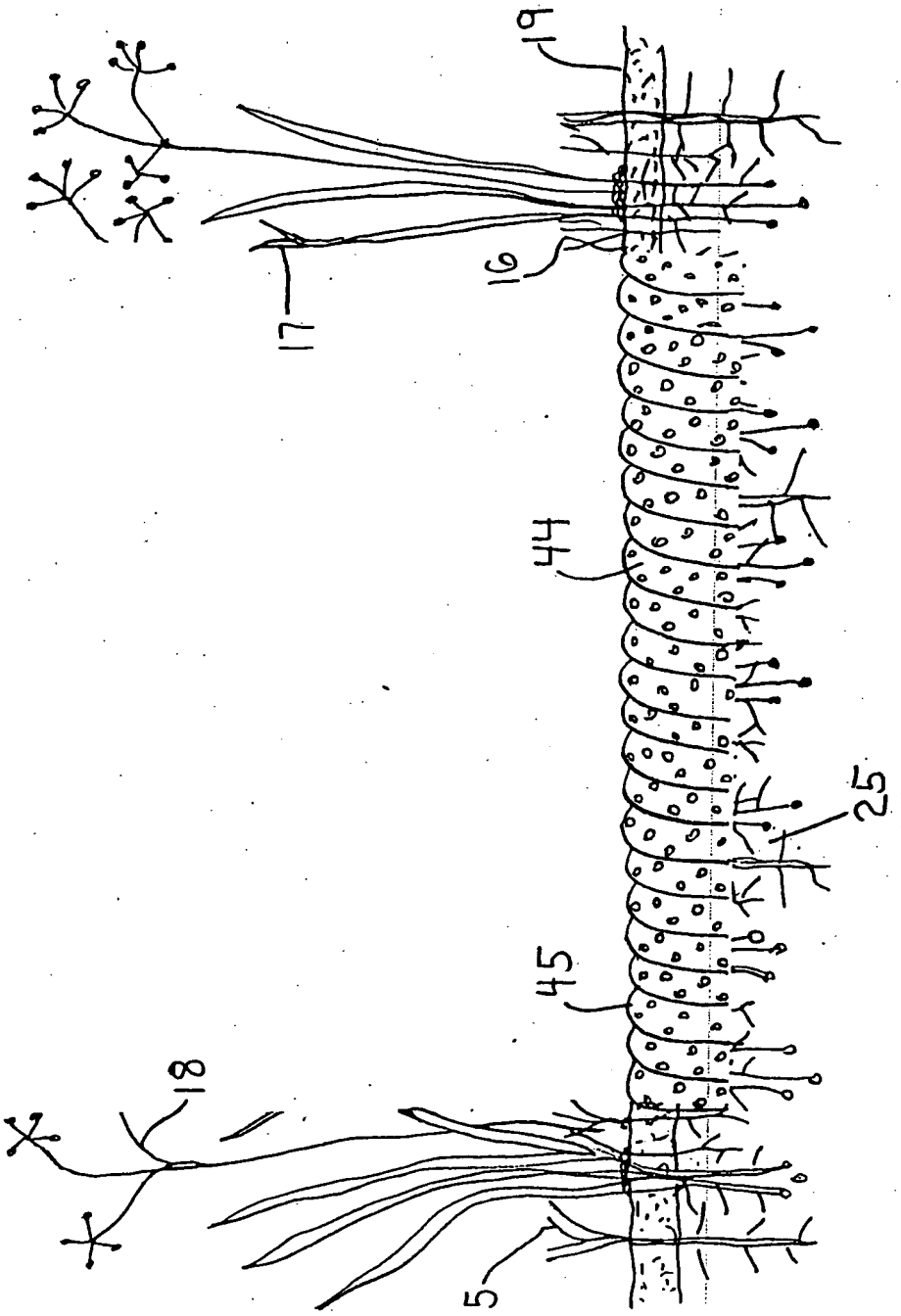


FIG.6

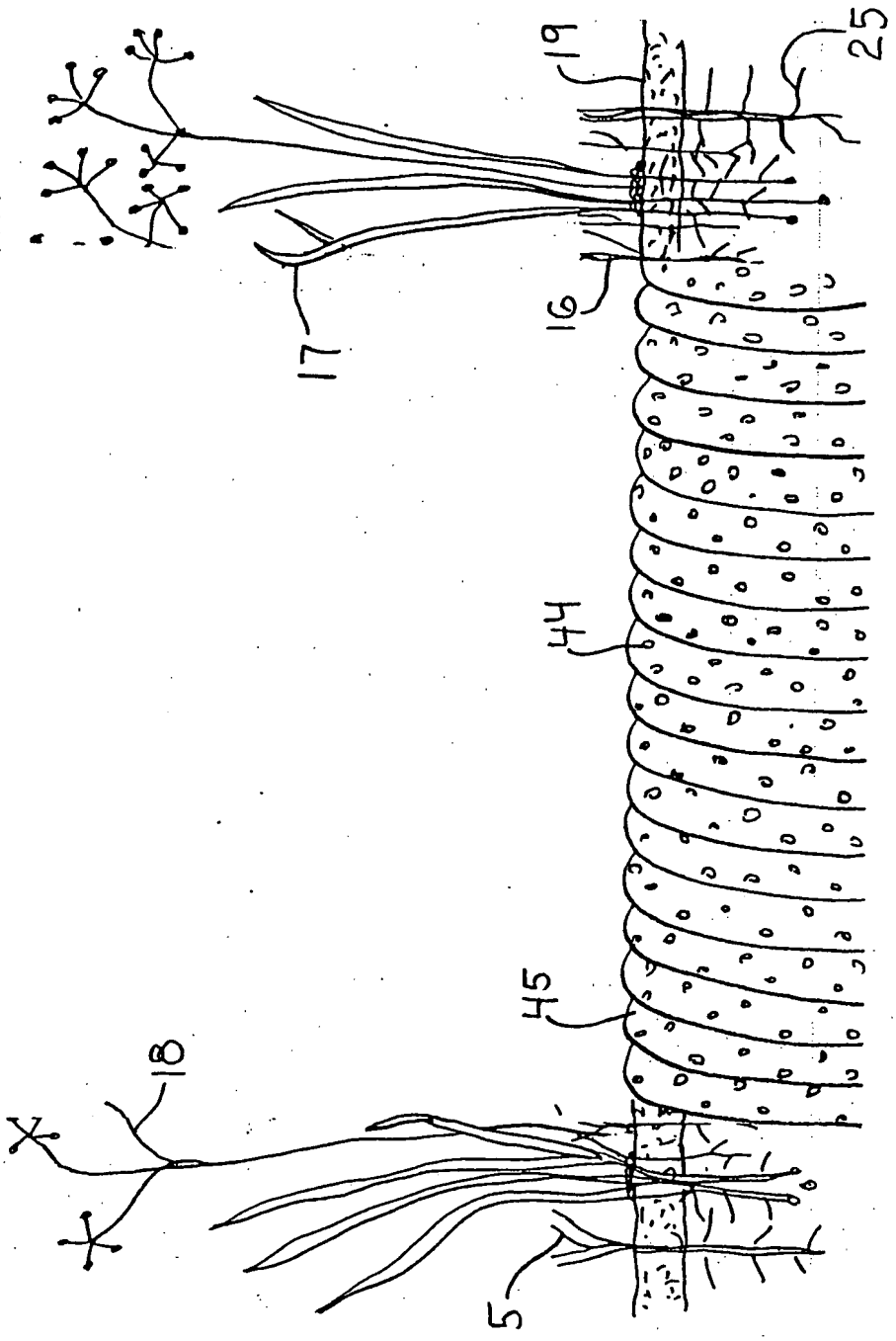


FIG. 7

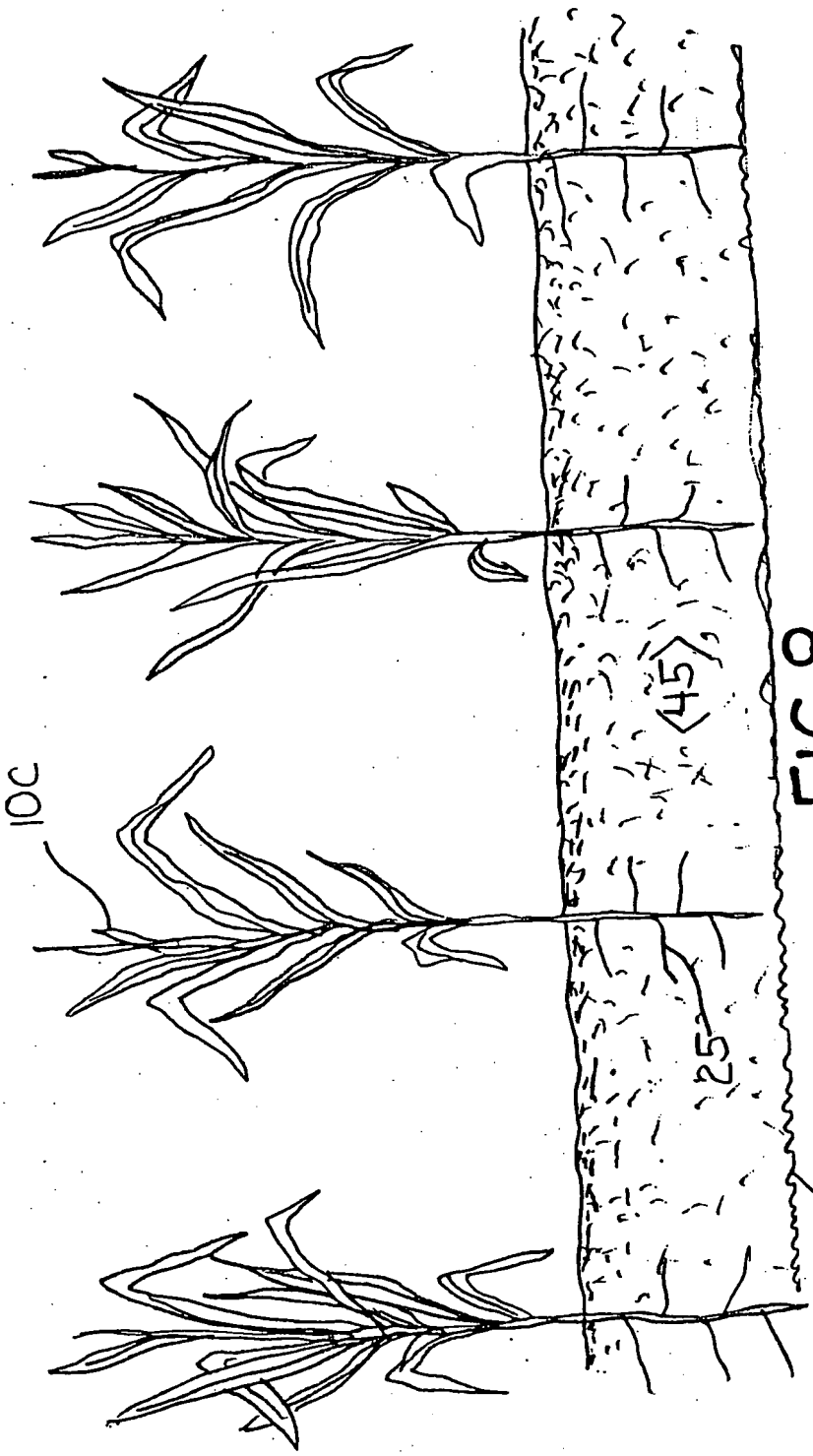


FIG.8
PRIOR ART

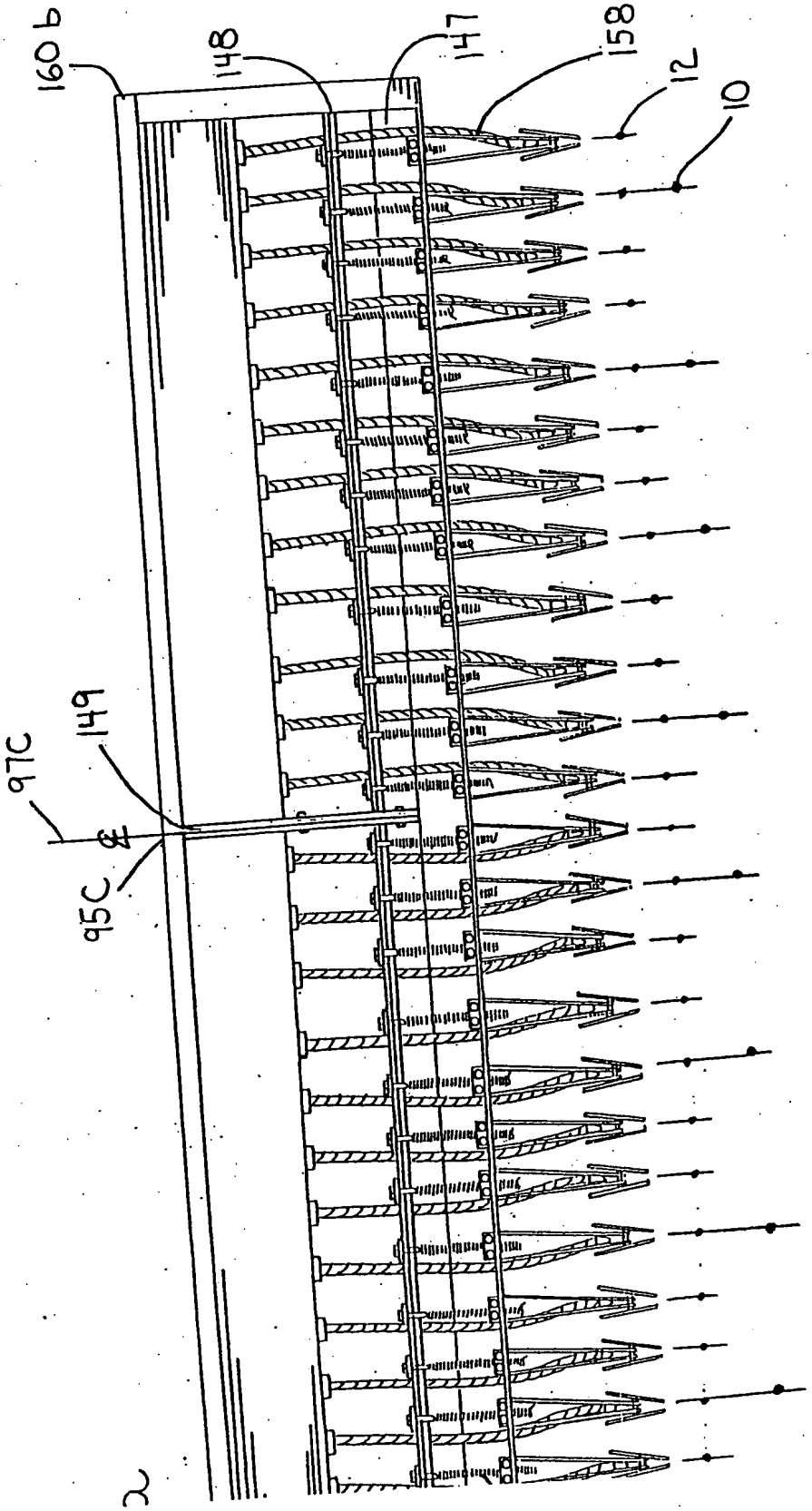
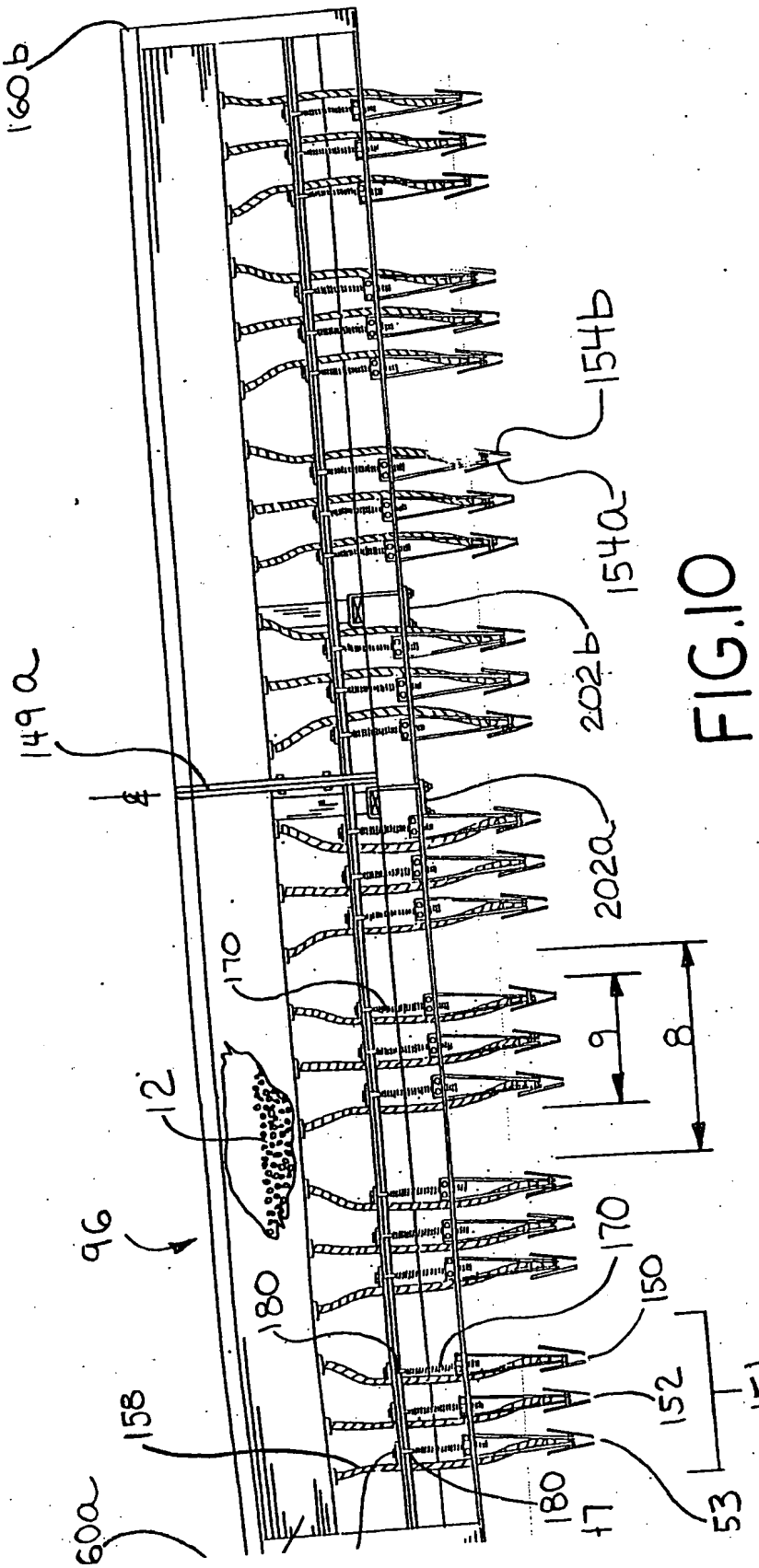


FIG.9
PRIOR ART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154a
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170
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96
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170
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158
152
151
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53
60a
9
8

FIG.10

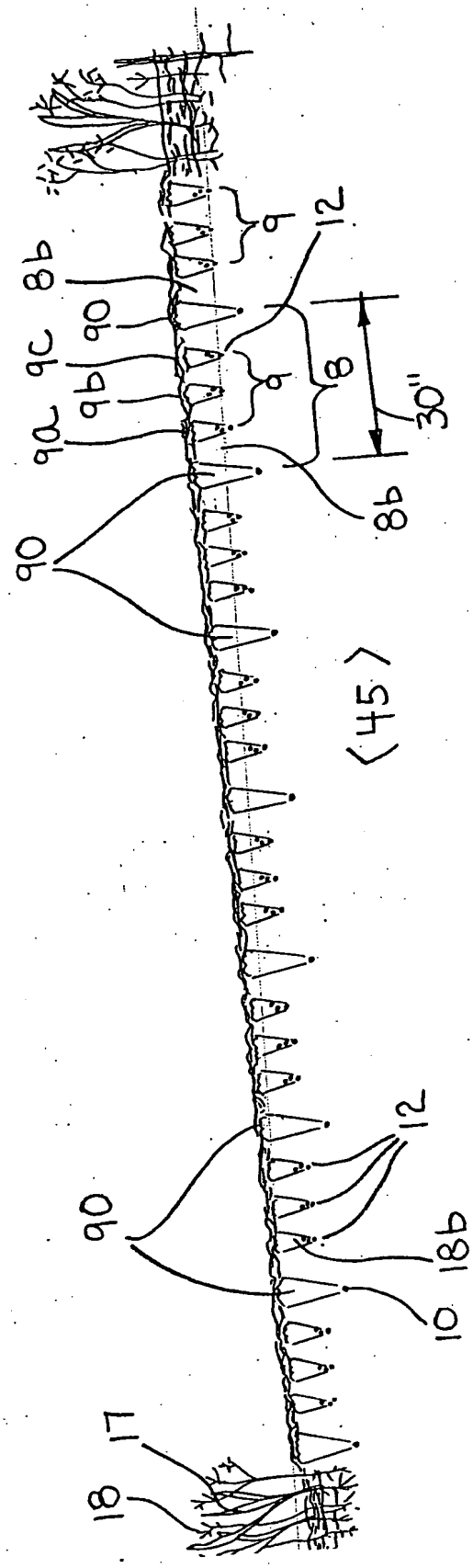
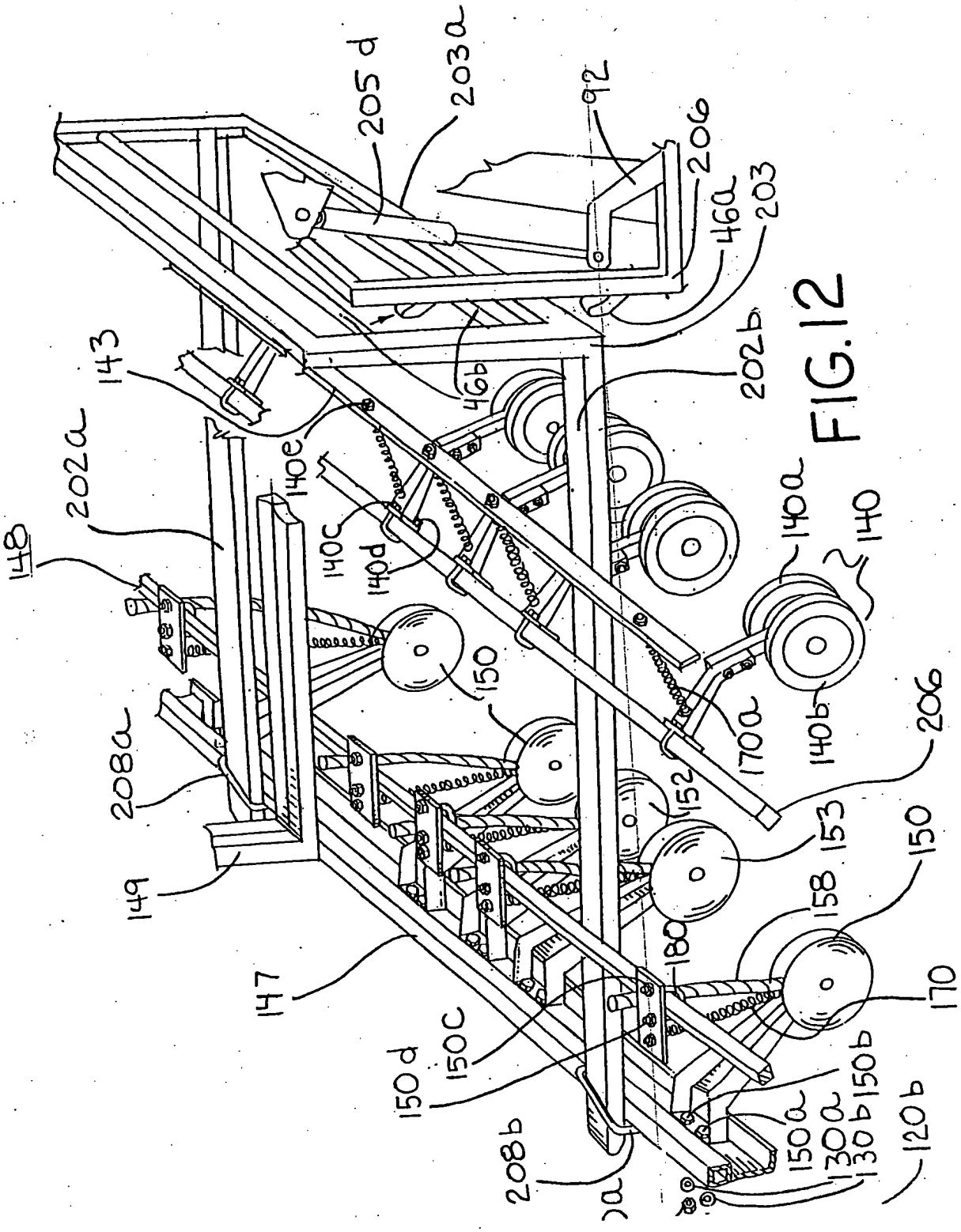


FIG. 11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140e
140c
140d
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140a
140
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208a
140b
170a
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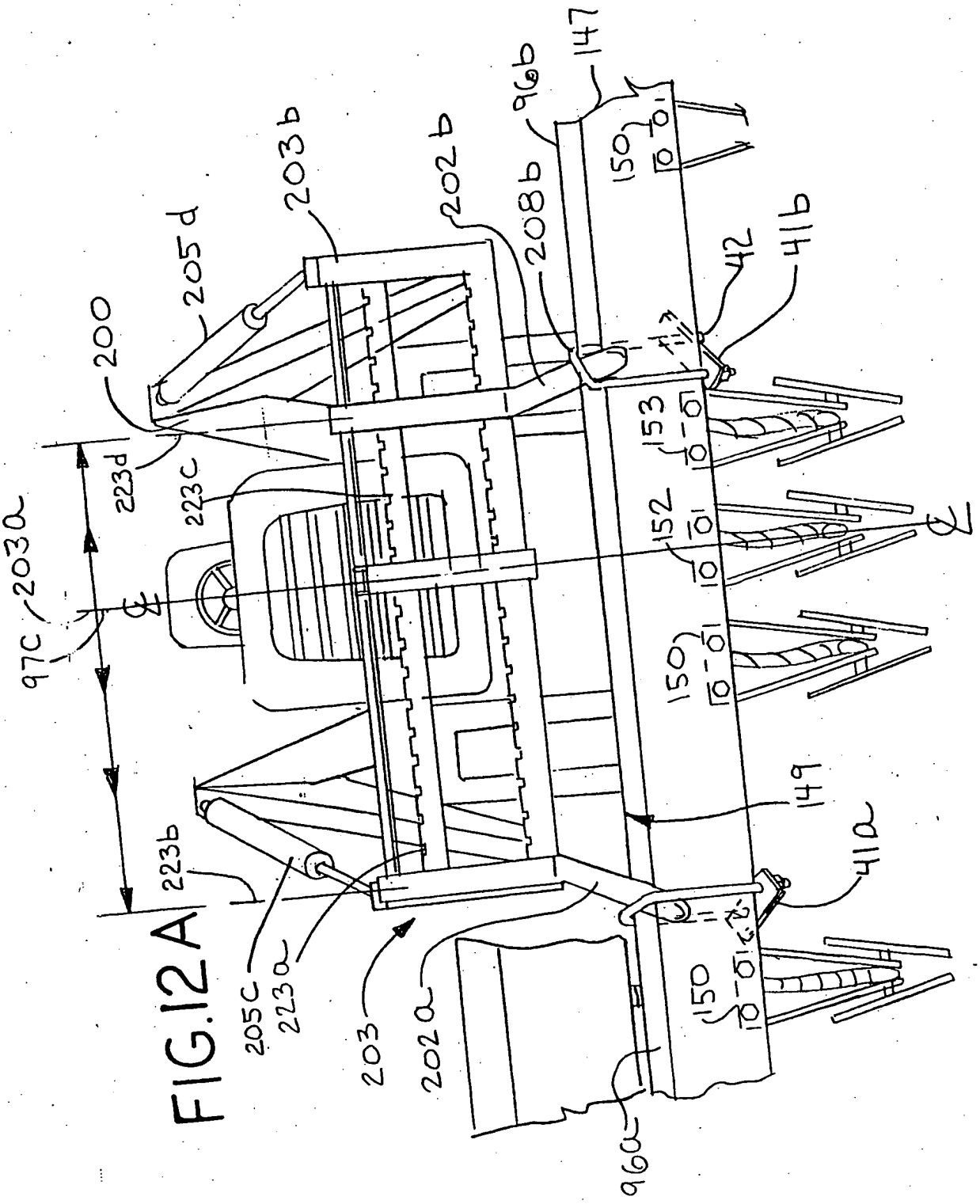
150b
150a
130a
130b
208b
120b

FIG. 12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147
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42
41b
153
152
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41a
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96a
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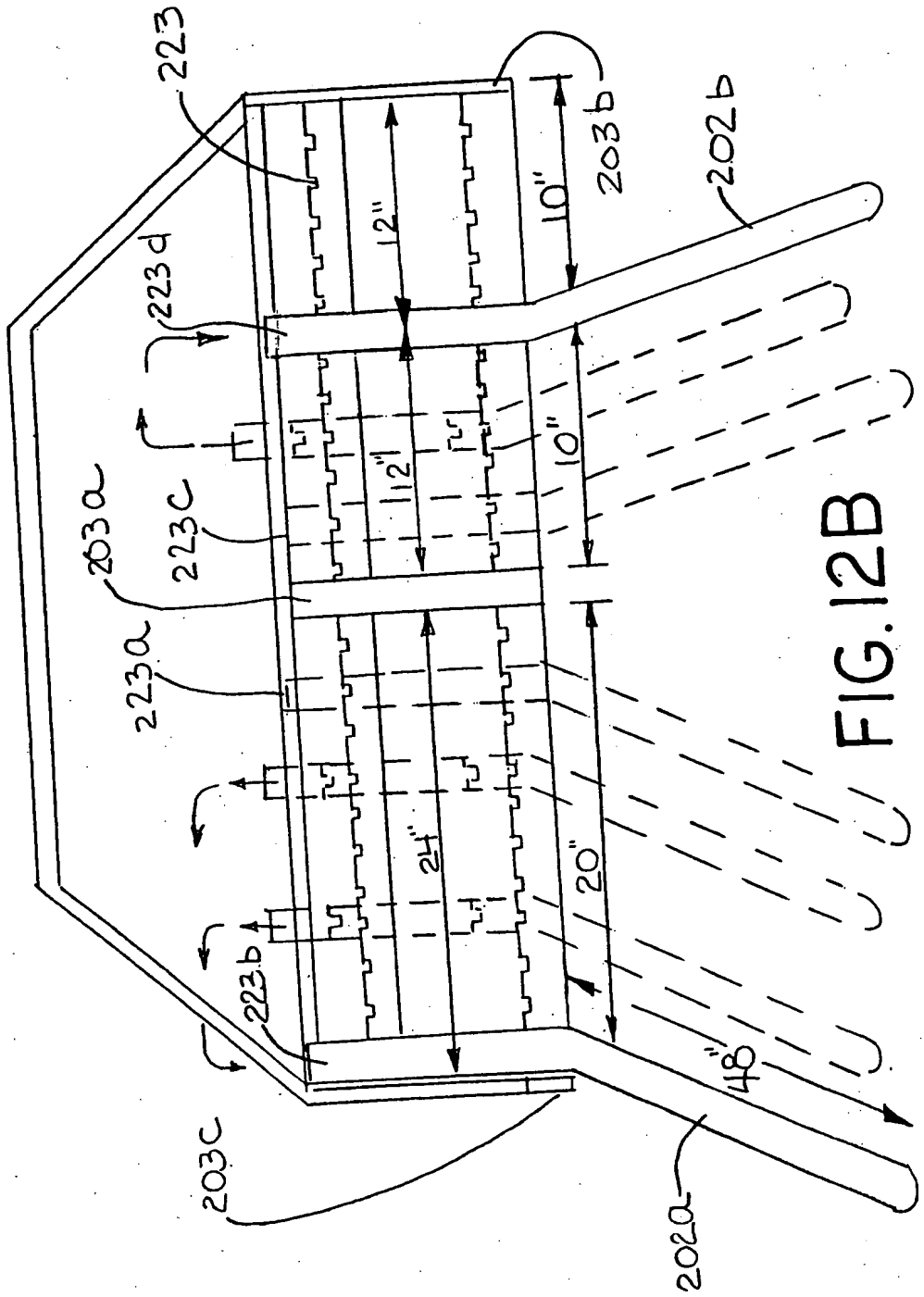
203
205c
223a
223b
223c
223d
203a
97c

FIG.12A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12"
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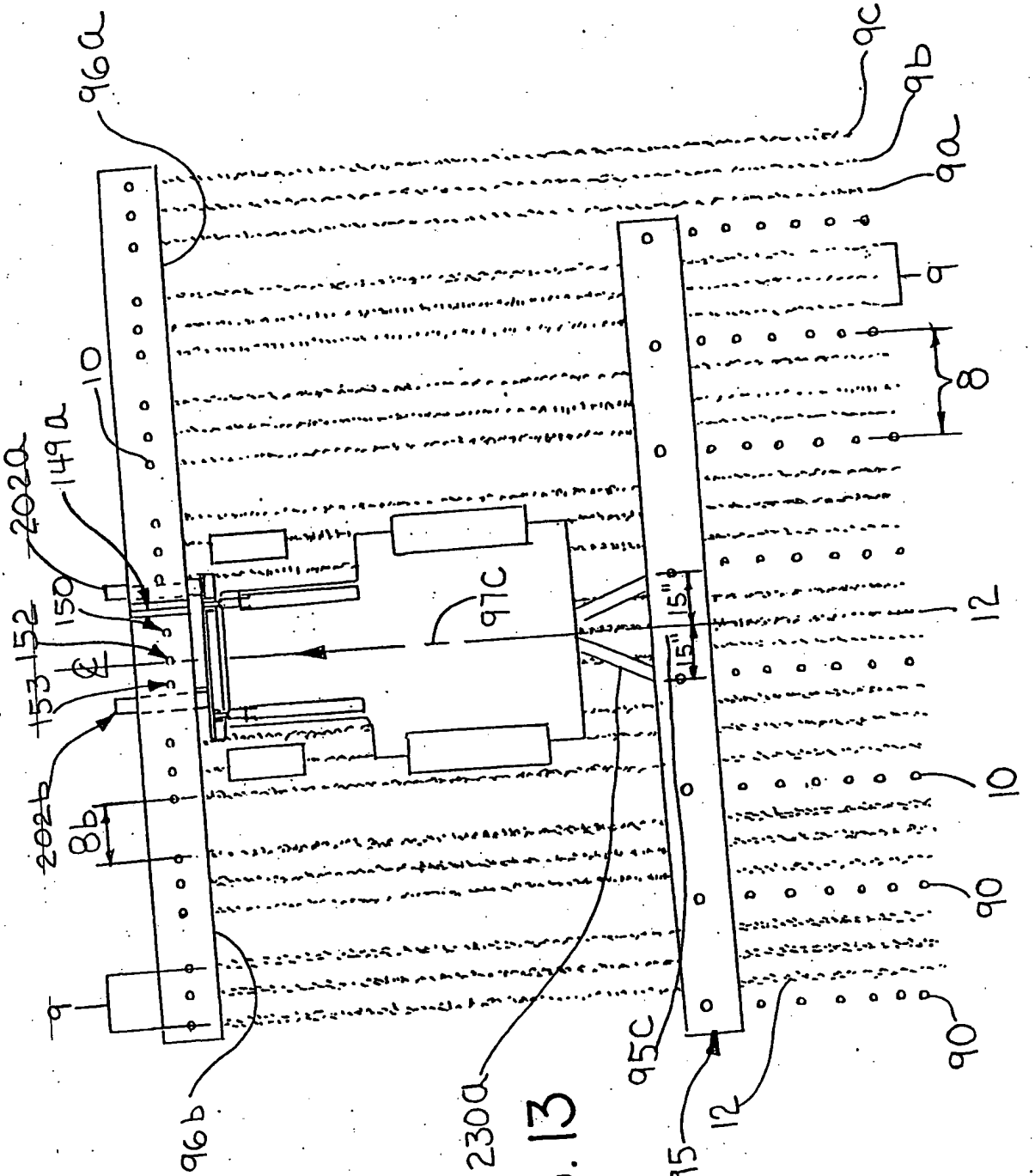
24"
20"
223b
48"
203c
202a

FIG. 12B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9b
9a
9
8
10
149a
202a
150
152
153
97c
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15"
15"
202b
8b
10
90
90
9
96b
230a
95c
95
12

FIG. 13

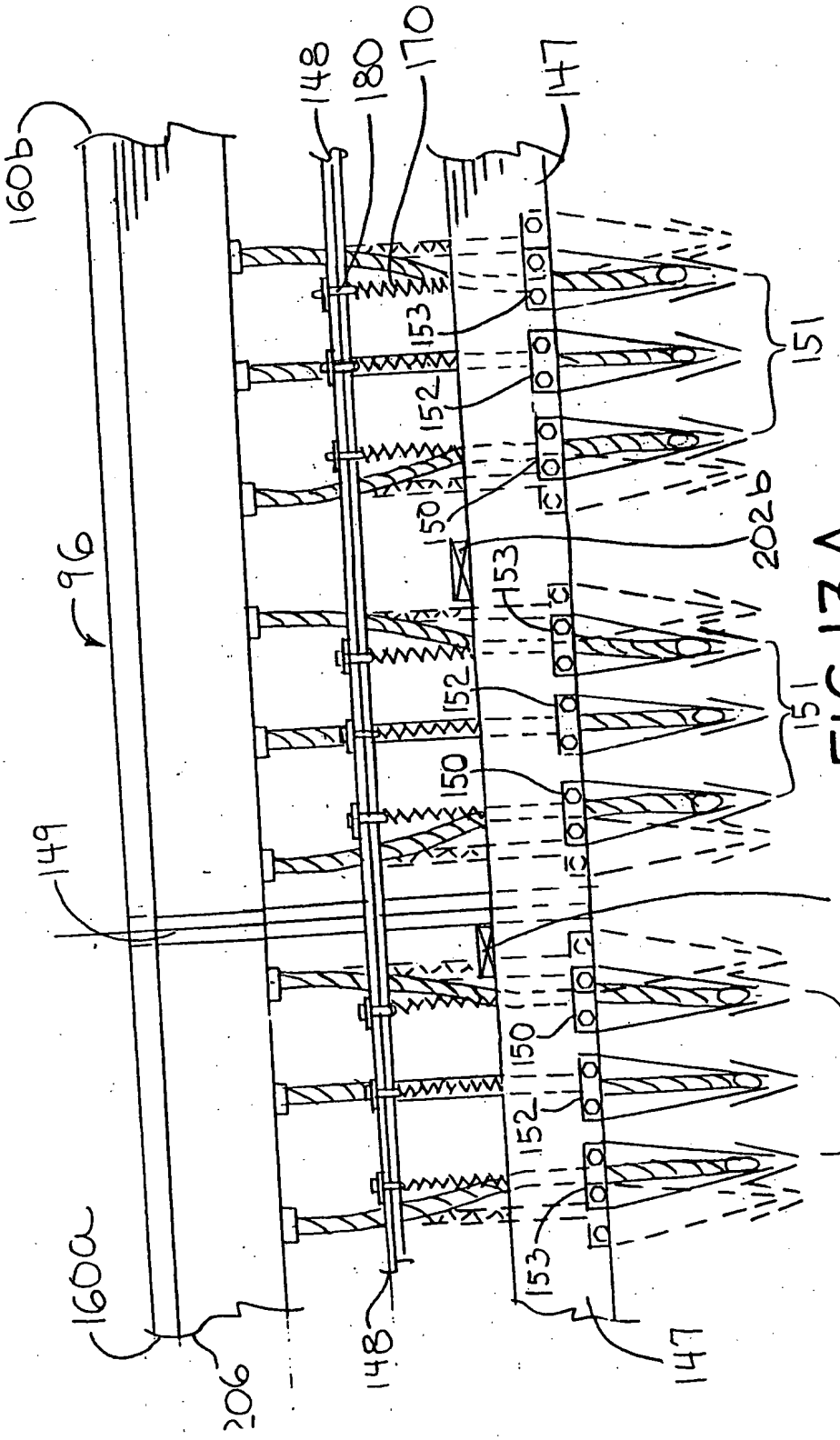

FIG. 13A

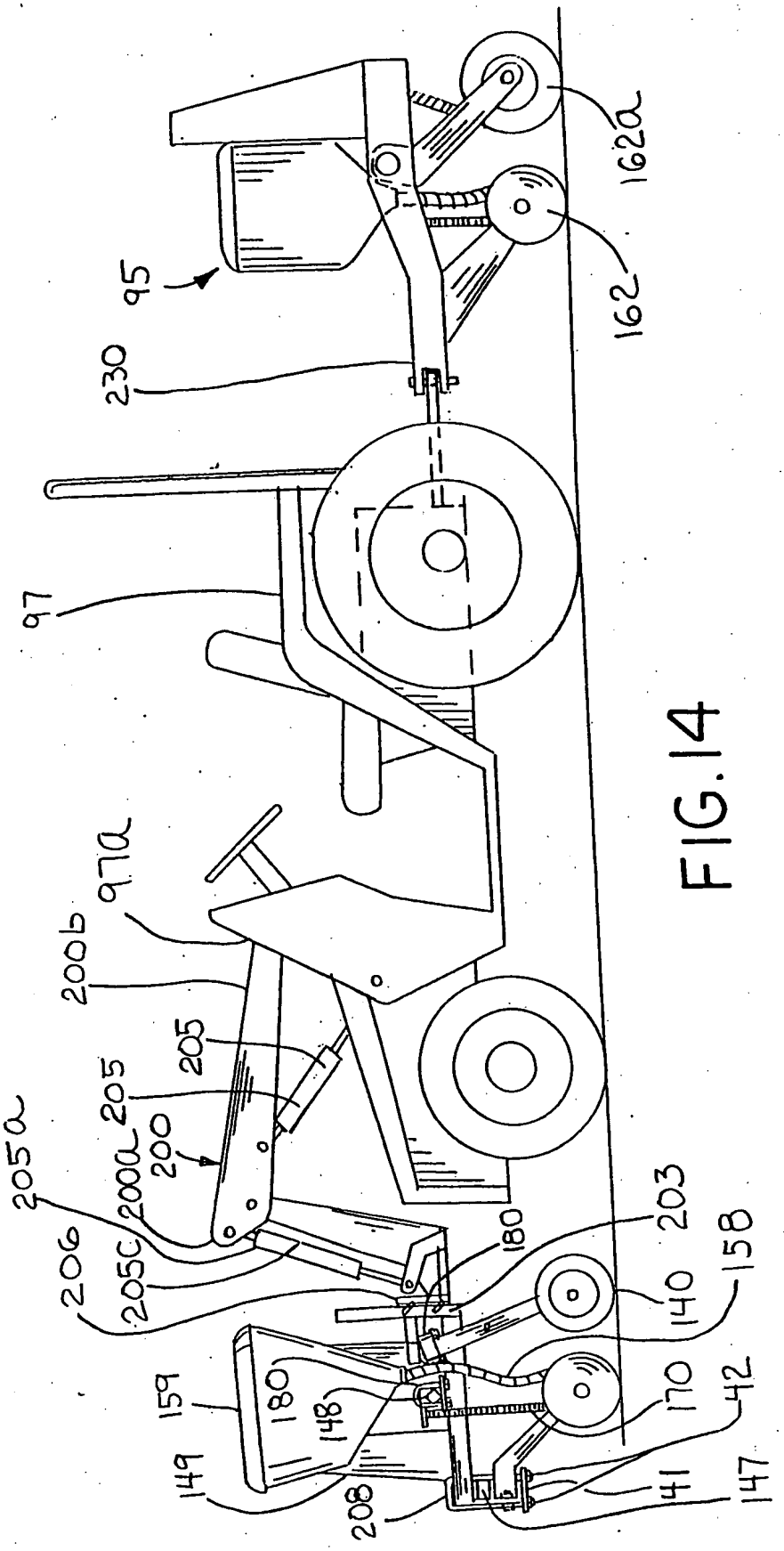
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FIG. 14

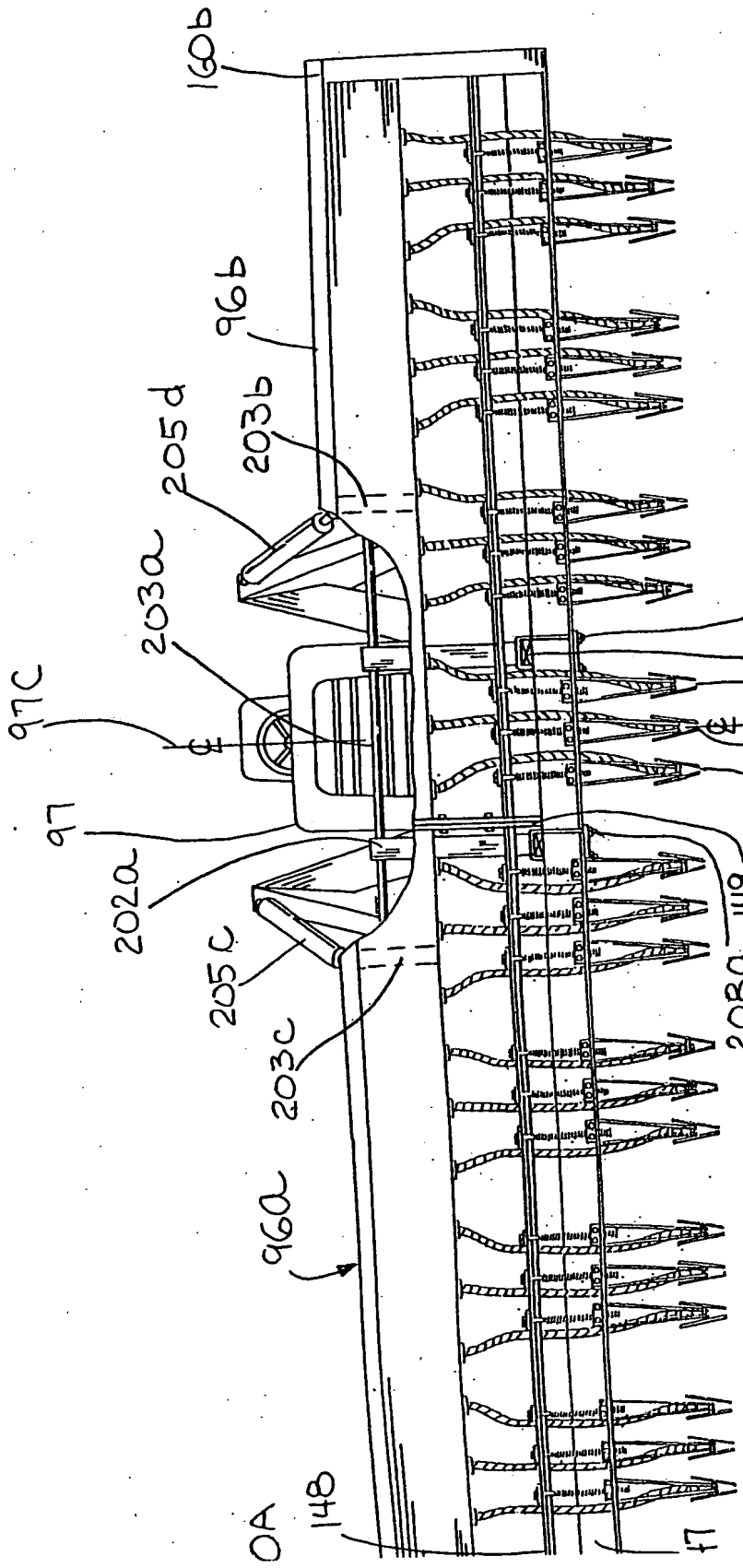
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FIG. 15A

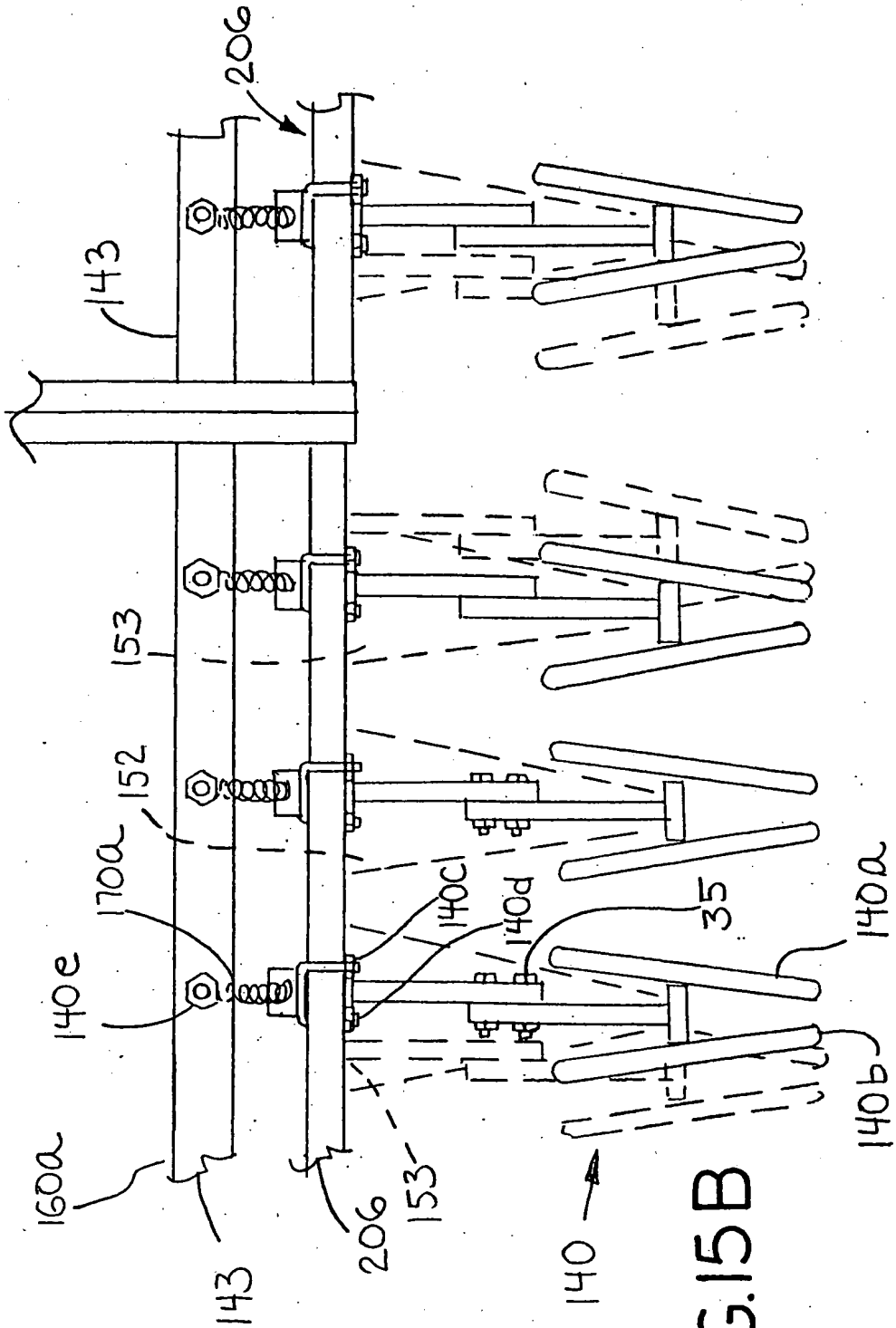
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FIG.15B

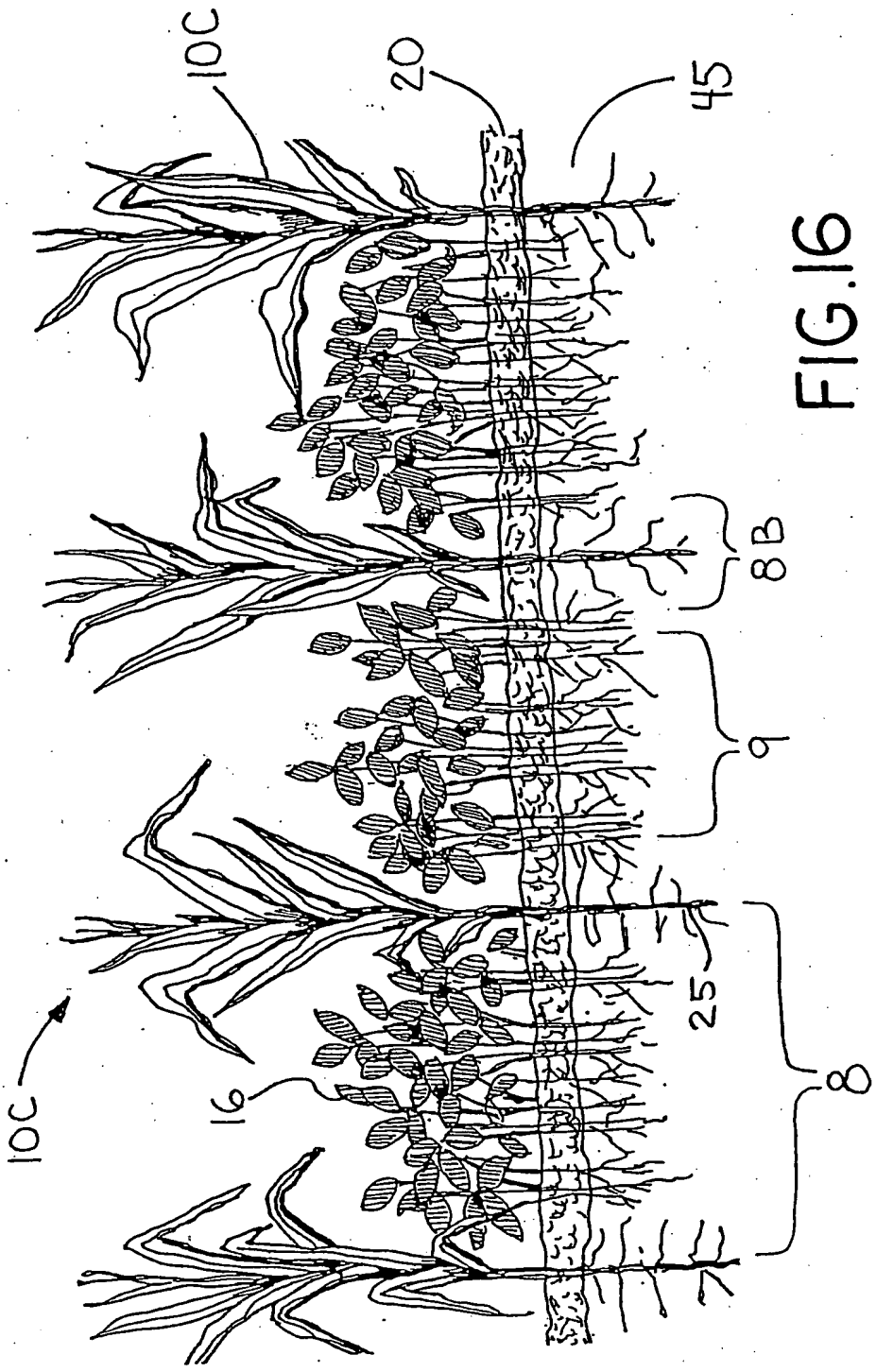
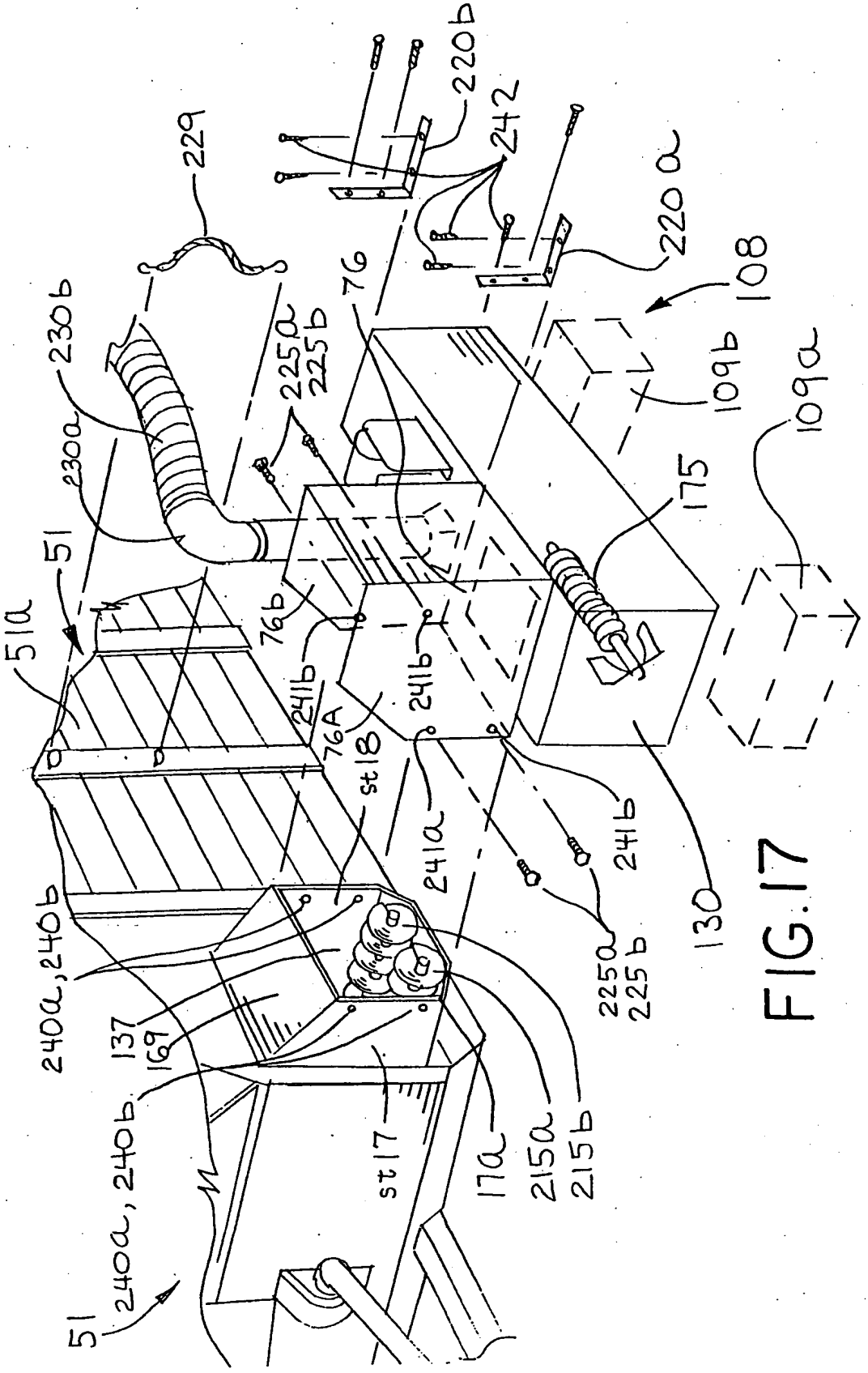


FIG.16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215b
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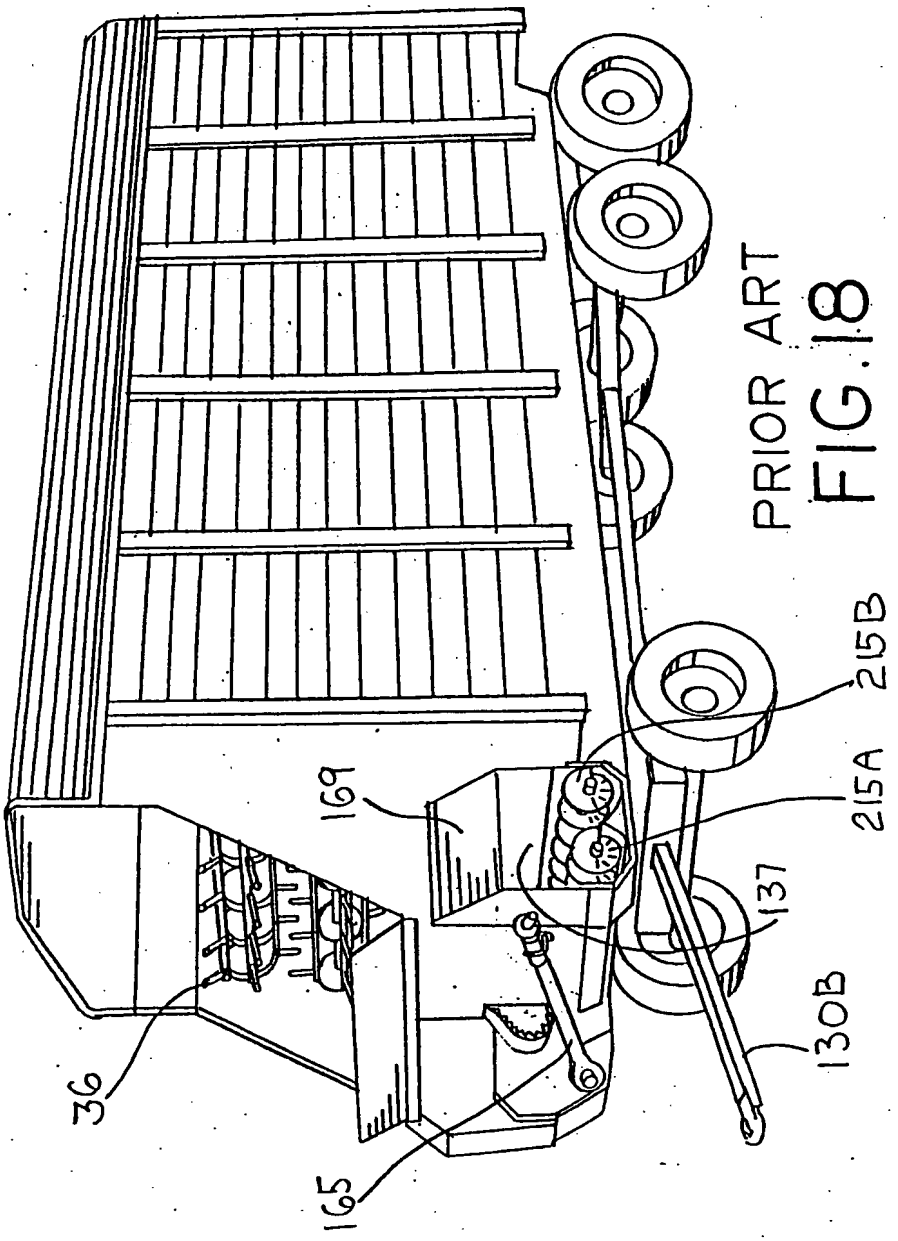
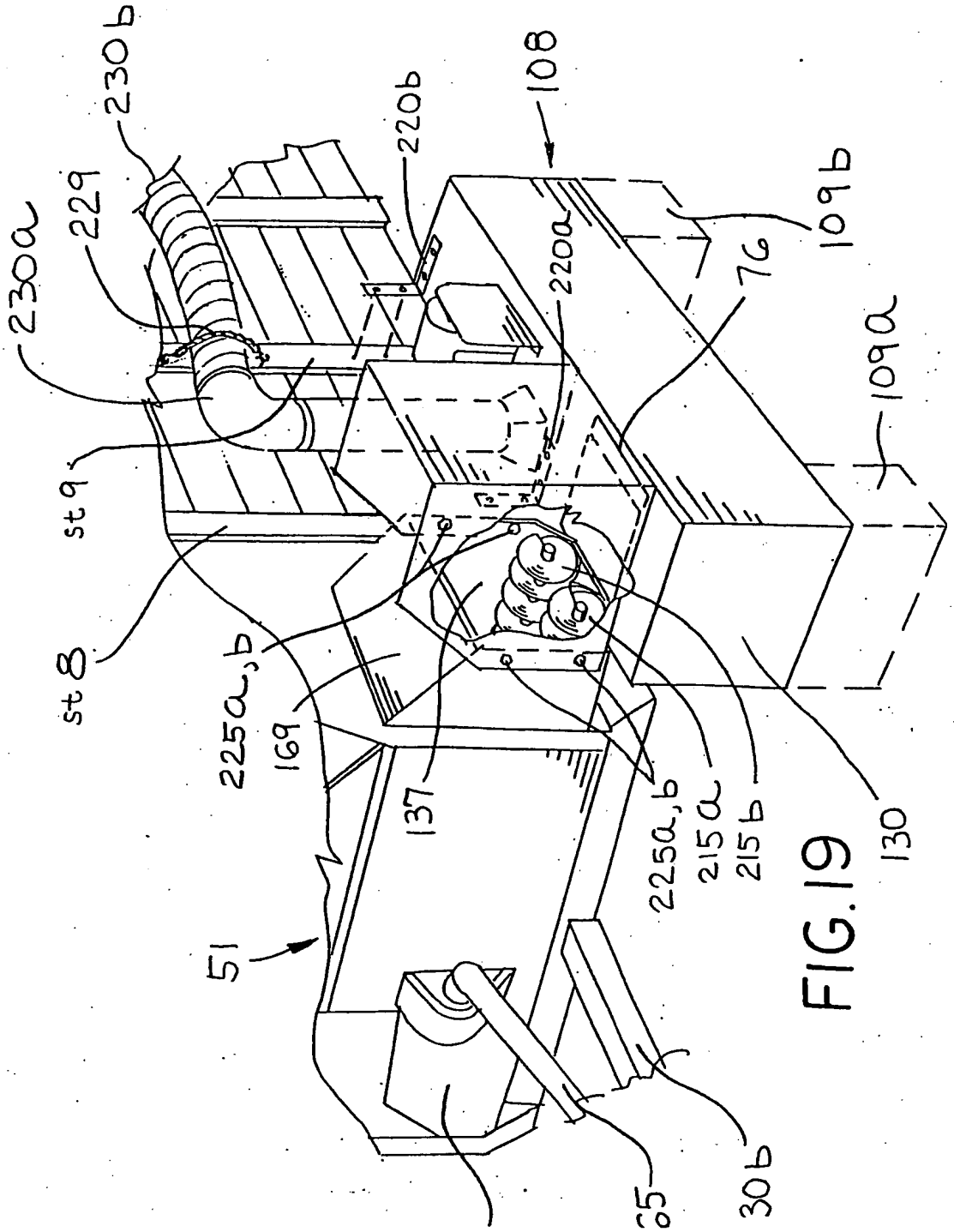
240a, 240b

FIG. 17



PRIOR ART
FIG. 18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215b
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30b

FIG. 19

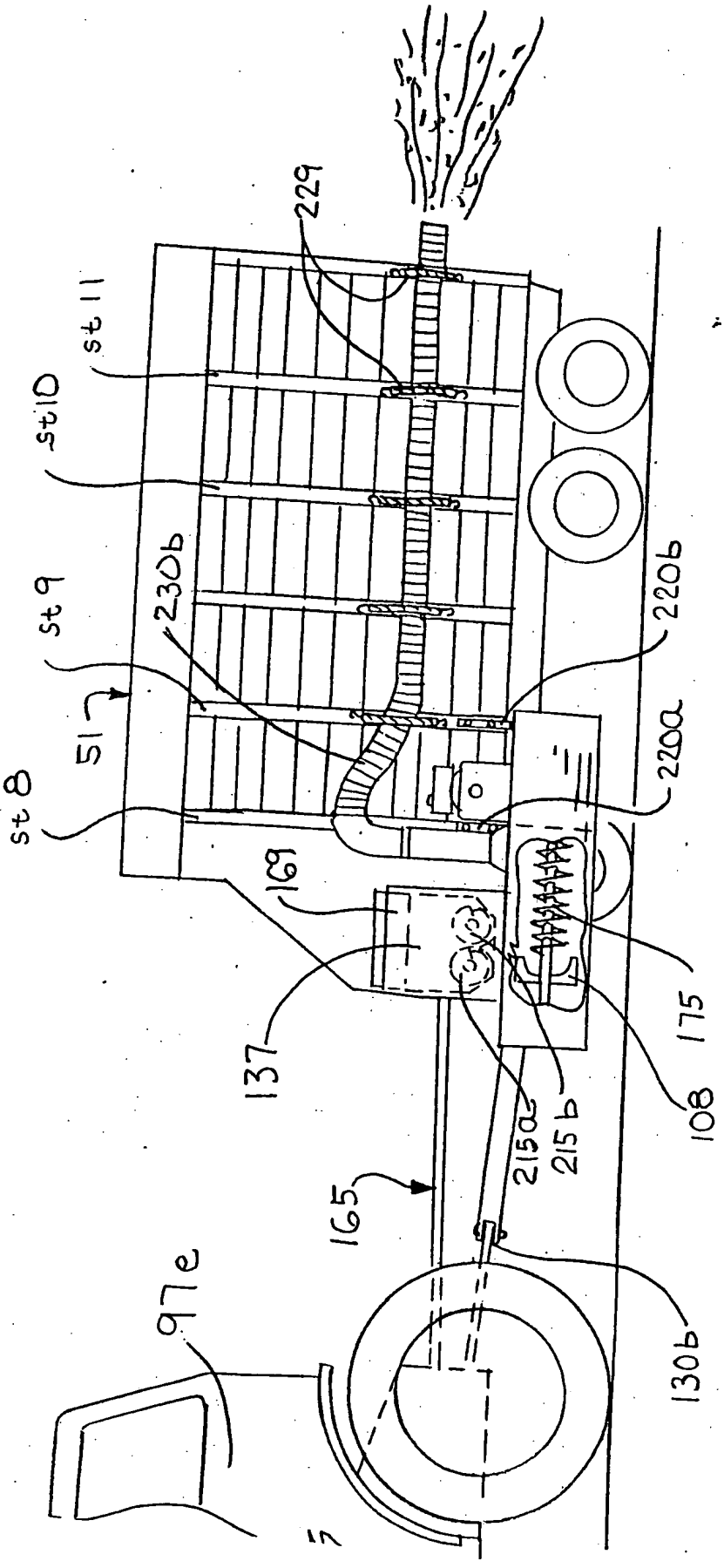
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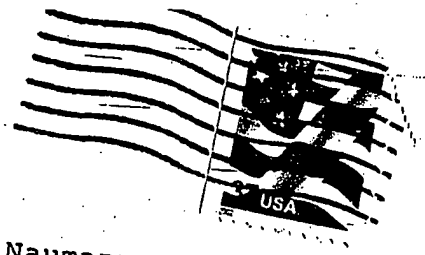
FIG. 20



Law Office of Adrienne B. Naumann

8210 North Tripp

Skokie, Illinois 60076

22154 U.S. PTO
10/747728

This postal card acknowledges the PTO's receipt of:

1. patention specification of 54(fifty-four) pages consecutively numbered ; check no. 4002 for $385.00 to Com'r for Patents
2. 24 (twenty-four) sheets of drawings consecutively numbered
3. goverment fee sheet and transmittal sheet
4. request for non- publicationform pto/sb/35
5. two-page declaration signed, pto/sb/01.

INventor and Applicant: Marvin J. Williams, Jr.; Title: IMproved Combined Intercropping and Mulching Method; Attorney of Record: Adrienne B. Naumann; Phone: 847-329-8185; fax: 847-329-8750; REg. No. 33,744; Exp. Mail No.ER 610722530 U.S.

Exhibit H

marvinjwilliamsjrelection –restrictoinmulchcip12-07-04.doc

December 27, 2004

Mr. Jeffrey L. Gellner
Art Unit 3643
United States Patent & Trademark Office
P.O. Box 1450
Alexandria, Virginia 22313-1450

REPLY TO OFFICE ACTION OF DECEMBER 3, 2004
ELECTION/RESTRICTION REQUIREMENT

Re:
Applicant and Inventor: Marvin J. Williams, Jr.
Application Number: 10/747,728
Filing Date: December 29, 2003
Art Unit: 3643
Examiner: Jeffrey L. Gellner

Applicant elects the following single disclosed species pursuant to the December 3, 2004 Office Action in the above captioned case:

Species I - B - soybean.

The claims readable thereon are as follows:

Claims 1, 2, 3, 4, 5, 6, 7, 9,10, 11, 12 and 13.

SUMMARY OF TELEPHONE CONFERENCE WITH EXAMINER

ON DECEMBER 6, 2004

Participants: Adrienne B. Naumann, Esq. and Examiner Jeffrey L. Gellner.

Topic: Restriction/election Requirement of Office Action of December 3, 2004.

Others present: None.

Exhibits or other Demonstrations: None.

Claims Discussed: Claims 1 –14.

Prior Art Discussed: None

Substantive Amendments Discussed: None

Matter Discussed:

Ms. Naumann inquired how Mr. Gellner designated species and grouped claims listed in the Office Summary per species in the December 3, 2004 Office Action. Mr. Geller explained that Claim 1 is an example of Species I, and Claim 14 is representative of Species II, because of the difference in farming methods. Ms. Naumann's understanding is that Species A is the method in which the mulch comprises buckwheat and is represented by Claim 8, while Species B is the method in which the mulch comprises buckwheat and wheat (which is represented by Claim 9). The species in which a commercial crop is soybeans is represented by Claim 3.

SUMMARY OF TELEPHONE CONFERENCE

WITH EXAMINER ON DECEMBER 8, 2004

Participants: Adrienne B. Naumann, Esq. and Examiner Jeffrey L. Gellner.

Topic: Restriction/election requirement of Office Action of December 3, 2004.

Others present: None.

Exhibits or other Demonstrations: None.

Claims Discussed: Claims 1 –14.

Prior Art Discussed: None

Matter Discussed:

Ms. Naumann stated Applicant's proposed claim groups to Mr. Gellner, who confirmed these groups for the election/restriction requirement as follows: Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, and13: I-B-soybean; Claims 8: I-A; Claim 14: Species II. He also clarified the basis for designation of buckwheat and wheat methods as separate species.

Respectively submitted,

_____

Marvin J. Williams, Esq.

Inventor and Applicant

By

Adrienne B. Naumann, Esq.

Reg. No. 33,744

Phone: 847-329-8185

Fax: 847-329-8750

This postal receipt card acknowleges the PTO's receipt of the following:

1. three-page reply to restriction requirement containing two telephone interview summaries; each page consecutively numered;
2. government transmittal form

Applicant and INventor: Marvin J. Williams, Jr.; Application No.: 10/747,728; filing date: 12-29-03; art United: 3643: Examiner: J. Gellner; Title: Improved INtercropping and Mulching Method; Attorney of Record: Adrienne B. Naumann, Esq.; phone: 847-329-8185; fax: 847-329-8750; U.S express Mail No. ER936009505 US

Exhibit I

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/747,728	12/29/2003	Marvin J. Williams JR.		2033

31156 7590 12/03/2004

LAW OFFICE OF ADRIENNE B. NAUMANN
8210 NORTH TRIPP
SKOKIE, IL 60076

EXAMINER	
GELLNER, JEFFREY	

ART UNIT	PAPER NUMBER
3643	

DATE MAILED: 12/03/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

December 27, 2004

Mr. Jeffrey L. Gellner
Art Unit 3643
United States Patent & Trademark Office
P.O. Box 1450
Alexandria, Virginia 22313-1450

REPLY TO OFFICE ACTION OF DECEMBER 3, 2004
ELECTION/RESTRICTION REQUIREMENT

Re:
Applicant and Inventor: Marvin J. Williams, Jr.
Application Number: 10/747,728
Filing Date: December 29, 2003
Art Unit: 3643
Examiner: Jeffrey L. Gellner

Applicant elects the following single disclosed species pursuant to the December 3, 2004 Office Action in the above captioned case:

Species I - B - soybean.

The claims readable thereon are as follows:

Claims 1, 2, 3, 4, 5, 6, 7, 9,10, 11, 12 and 13.

SUMMARY OF TELEPHONE CONFERENCE WITH EXAMINER

ON DECEMBER 6, 2004

Participants: Adrienne B. Naumann, Esq. and Examiner Jeffrey L. Gellner.

Topic: Restriction/election Requirement of Office Action of December 3, 2004.

Others present: None.

Exhibits or other Demonstrations: None.

Claims Discussed: Claims 1 –14.

Prior Art Discussed: None

Application No.	Applicant(s)
10/747,728	WILLIAMS, MARVIN J.
Examiner	**Art Unit**
Jeffrey L. Gellner	3643

Office Action Summary

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 1 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If the period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *1-14* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

This application contains claims directed to the following patentably distinct species of the claimed invention:

Species I: method with intercropping with first planting an annual green manure crop

Species II: method of intercropping with first planting a commercial legume crop

Upon election of Species I, Applicant is further required under 35 USC 121 to elect among the patentably distinct species of the claimed invention:

Species A: green manure crop is buckwheat

Species B: green manure crop is buckwheat and wheat

Also, upon election of Species I, Applicant is further required under 35 USC 121 to elect among the patentably distinct species of the claimed invention:

election of one of the legume commercial crops from: soybean, Austrian peas, hairy vetch, red clover, annual ryegrass, and winter rye

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species combination (for example, Species I - B - soybean) for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, no claims appear generic.

Applicant is advised that a reply to this requirement must include an identification of the species that is elected consonant with this requirement, and a listing of all claims readable thereon, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election.

Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by 37 CFR 1.141. If claims are added after the election, applicant must indicate which are readable upon the elected species. MPEP § 809.02(a).

Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

Conclusion

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Jeffrey L. Gellner whose phone number is 703.305.0013. The Examiner can normally be reached Monday through Thursday from 8:30 am to 4:00 pm. The Examiner can also be reached on alternate Fridays.

If attempts to reach the Examiner by telephone are unsuccessful, the Examiner's Supervisor, Peter Poon, can be reached at 703.308.2574. The official fax telephone number for the Technology Center where this application or proceeding is assigned is 703.872.9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703.308.1113.

Jeffrey L. Gellner
Primary Examiner

Substantive Amendments Discussed: None

Matter Discussed:

Ms. Naumann inquired how Mr. Gellner designated species and grouped claims listed in the Office Summary per species in the December 3, 2004 Office Action. Mr. Geller explained that Claim 1 is an example of Species I, and Claim 14 is representative of Species II, because of the difference in farming methods. Ms. Naumann's understanding is that Species A is the method in which the mulch comprises buckwheat and is represented by Claim 8, while Species B is the method in which the mulch comprises buckwheat and wheat (which is represented by Claim 9). The species in which a commercial crop is soybeans is represented by Claim 3.

SUMMARY OF TELEPHONE CONFERENCE

WITH EXAMINER ON DECEMBER 8, 2004

Participants: Adrienne B. Naumann, Esq. and Examiner Jeffrey L. Gellner.

Topic: Restriction/election requirement of Office Action of December 3, 2004.

Others present: None.

Exhibits or other Demonstrations: None.

Claims Discussed: Claims 1 –14.

Prior Art Discussed: None

Matter Discussed:

Ms. Naumann stated Applicant's proposed claim groups to Mr. Gellner, who confirmed these groups for the election/restriction requirement as follows: Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, and13: I-B-soybean; Claims 8: I-A; Claim 14: Species II. He also clarified the basis for designation of buckwheat and wheat methods as separate species.

Respectively submitted,

_____

Marvin J. Williams, Esq.

Inventor and Applicant

By

Adrienne B. Naumann, Esq.

Reg. No. 33,744

Phone: 847-329-8185

Fax: 847-329-8750

marvinjwilliamsjrpostnoticeofappealamendment6-22-06.doc
6-23-06

IN THE UNITED STATES OFFICE OF PATENTS & TRADEMARKS
PATENTS

July 6, 2006

To: U.S. Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

POST NOTICE OF APPEAL AMENDMENT
PURSUANT TO 37 C.F.R SECTION 41.33(a)

Re:

Applicant and Inventor: Mr. Marvin J. Williams, Jr.

U.S. Application No.: 10/747,728

Filing Date: December 29, 2003

Art Unit: 3643

Examiner: Jeffrey L. Gellner

Dear Sir or Madam:

Please amend the above captioned U.S. patent application as follows:

Changes to the claims begin on page 2 of this paper.

Remarks begin on page 9 of this paper.

IN THE CLAIMS

(Not entered) Claim 1: An improved intercropping and mulching method without artificial herbicides, fertilizer, pesticides and manure, said improved intercropping and mulching method comprising:

(1) no-till planting an annual green manure crop in the soil of a predetermined area;

(2) mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue from said predetermined area to form combined green manure, said organic residue comprising desiccated intact soybean roots and desiccated intact nitrogen nodules, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure, said second portion of said combined green manure further blended with said soil of said predetermined area to a depth of approximately nine to fourteen inches, said annual green manure crop remaining unmowed until tillage of said soil,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure, said first portion of said combined green manure being collected, chopped and stored until intercropping is complete, said first portion of said combined green manure becoming said combination mulch after said chopping,

(4) thereafter spraying said first portion of said combination mulch upon the surface of said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two commercial crops, said annual green manure crop and said organic residue protecting said soil of said predetermined area during the winter.

(Not entered) Claim 2. The improved intercropping and mulching method as described in Claim 1, wherein one of said at least two commercial crops comprises a legume.

(Not entered) Claim 3. The improved intercropping and mulching method as described in Claim 1, wherein one of said at least two commercial crops comprises soybeans.

(Not entered) Claim 4. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn.

(Not entered) Claim 5. The improved intercropping and mulching method of Claim 1 wherein one of said at least two commercial crops comprises corn and one of said at least two commercial crops comprises soybeans.

(Not entered) Claim 6. The improved intercropping and mulching method as described in Claim 1, wherein there are no intercropped plants other than said at least two commercial crops, said at least two commercial crops comprising said corn and said soybeans.

(Not entered) Claim 7. The improved intercropping and mulching method as described in Claim 6 wherein said corn and said soybeans are planted in alternating patterns comprising soybean areas and corn rows, each said soybean area and said corn row comprising a predetermined lateral width.

(Withdrawn) Claim 8.

(Currently amended) Claim 9. An improved intercropping and mulching method comprising:

(1) planting an annual green manure crop in the soil of a predetermined area;

(2) mowing said annual green manure crop the following spring, said annual green manure crop being combined with organic residue to form combined green manure, said combined green manure comprising a first portion of said combined green manure and a second portion of said combined green manure further blended with said soil of said predetermined area, said first portion of said combined green manure being mechanically collected and mechanically chopped and thereby becoming a combination mulch,

(3) intercropping at least two commercial crops within said soil blended with said second portion of said combined green manure, said combination mulch being stored during said intercropping,

(4) thereafter spraying said first portion of said ~~combined~~ combination mulch upon said soil of said predetermined area, said predetermined area now containing seeds of said at least two commercial crops,

whereby said combined green manure provides nutrients to said at least two commercial crops and said combination mulch provides a ground cover and nutrients for said at least two commercial crops, said annual green manure crop and said organic residue protecting said soil of said predetermined area during the winter,

one of said at least two commercial crops comprising a legume,

One of said two commercial crops further comprising soybeans,

one of said at least two commercial crops comprising corn,

said at least two commercial crops comprising corn and soybeans,

there being no intercropped plants other than said at least two commercial crops comprising corn and soybeans,

Said corn and said soybeans planted in alternating patterns comprising corn rows and soybean areas respectively, each said soybean area and said corn row comprising a predetermined lateral width,

said annual green manure crop selected from the group consisting of ~~buckwheat or buckwheat and~~ wheat, Austrian peas, hairy vetch, soybeans, annual rye grass and winter rye.

(Not entered) Claim 10. The improved intercropping and mulching method as described in Claim 9, wherein said annual green manure crops are mowed with a conventional mechanical forage harvester.

(Currently amended) Claim 11. The improved intercropping and mulching method as described in Claim 10,

wherein said combination ~~green manure~~ mulch is sprayed upon said soil of said predetermined area after blending and chopping of said green manure plants and organic debris within a bale chopper.

(Not entered) Claim 12. The improved intercropping and mulching method as described in Claim 11 wherein said intercropped soybeans are planted simultaneously with said intercropped corn by using a fork lift attachment with two forks, front end loader and tractor, corn planter, and a modified seed drill, said modified seed drill and said fork lift attaching to said tractor by said front end loader, said fork lift attachment elevated with a hydraulic lift and a retrofit adapter.

(Not entered) Claim 13. The improved intercropping and mulching method as described in Claim 12 wherein said corn planter deposits said corn seeds between previously planted said soybean areas, said soybean areas consisting of soybean subrows, said

soybean subrows deposited by said modified seed drill attached to [said] a tractor, said corn seeds deposited within straight corn furrows.

(Withdrawn) Claim 14.

(Currently amended) Claim 15. The method described in Claim [[14]] 7 wherein [said] soybean seeds are planted at approximately eight to twenty seeds per square foot of said soil and [said] corn seeds are planted at approximately one corn seed per eight linear inches of said soil, said soybean seeds planted during the same pass across said preselected soil as said corn seeds.

(Currently amended) Claim 16. The method described in Claim [[14]] 7 wherein [[said]] a modified seed drill comprises eight [[said]] sets of [said] tru-vee openers and one center bar, a single said set of said tru-vee openers fitting between [[said]] first and second forks, said single set of tru-vee openers positioned immediately proximal to either side of said center bar, each said first and second fork resting upon [[said]] an opener draw bar on either side of said single said set of said tru-vee openers, each said first and second fork attached to said opener draw bar by a clamp.

(Currently amended) Claim 17. The method described in Claim [[14]] 7 wherein ~~each~~ ~~said~~ three soybean subrows comprising a soybean area [[is]] are approximately 21 inches in total lateral width.

(Currently amended) Claim 18. The method as described in Claim [[14]] 7 wherein rotating augers pull said organic debris and said green manure plants from said forage box wagon into [[said]] a bale chopper, said bale chopper attaching to a discharge opening by sliding said bale chopper until interior surfaces of a bale tube fit snugly over exterior surfaces of panels of [[said]] an attached ~~storage~~ forage box wagon.

(Currently amended) Claim 19. The method as described in Claim [[14]] 16 wherein said true-vee openers are arranged in said sets of three, thereby leaving lateral space between each said set along said horizontal bar, each said set seeding soybeans within said three said soybean subrows when said modified seed drill is pulled by [[said]] a tractor, each said lateral space resulting in unseeded soil, said unseeded soil then seeded with said corn seed within said corn furrows while said corn planter is pulled by said tractor, said seeding of said corn seed and said soybean seed occurring with said modified seed drill and [[said]] corn planter operatively attached to said ~~a single~~ tractor.

(Currently amended) Claim 20. The method as described in Claim 19 wherein said two sides of a bale tube attach to said bale chopper, said two sides of said bale tube snugly fitting over an anterior and posterior panel, said anterior and posterior panels surrounding said augers of said forage box wagon, said sides of said bale tube mechanically attached to said anterior and posterior panels, said forage box wagon physically attaching to a [[said]] bale chopper main frame with L-brackets, said green manure plants and organic debris chopped within said bale chopper main frame after passing said augers.

REMARKS

1. Appellant has modified claim 9 to omit the withdrawn species of buckwheat, pursuant to Applicant's Reply to the government's Restriction/Election of Species Requirement. Evidence Appendix, Exhibit I.

2. Appellant has modified Claims 15 through 20 to avoid dependence from withdrawn Claim 14.

3. Appellant has modified claims 9, 11 15, 16, 17, 18, 19 and 20 to designate correct antecedent basis.

Appellant amended claims which were inadvertently drafted to include no-elected species (Claim 8) and a restricted invention (Claim 14). The government addressed these claims and the depending claims in its second final office action, based upon enablement

and not withdrawal of non –elected matter. Consequently, enablement became the focus of Appellant's response to that final office action, and within his time constraints.

Respectively submitted,

Adrienne B. Naumann,

Attorney of Record,

Reg. No. 33,744

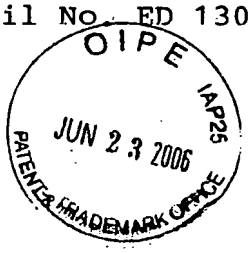
On behalf of

Marvin J. Williams, Jr., Inventor and Appellant

This postal receipt card acknowleges the PTO's receipt of the following:

1. 11 page, pages consecutively numbered post notice of appeal amendment
2. transmission sheet

Applicant and INventor: Marvin J. Williams, Jr.; Application No.: 10/747,728; Fioling date: 12-29-03; Art Unit: 3643; Examiner: J. Gellner; Attorney of Record: Adrienne B. Naumann, Esq.; phone: 847-329-8185; U.S. Express Mail No. ED 130362598 US



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PATENT APPLICATION INFORMATION RETRIEVAL

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Search results as of: 7-1-2006::16:5

Search results for application number:10/747,728

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Application Type:	Utility	Status Date:	05-16-2006
Examiner Name:	GELLNER, JEFFREY L	Location:	ELECTRON
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Confirmation Number:	2033	Earliest Publication No:	-
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Class/ Sub-Class:	047/009	Patent Number:	-
First Named Inventor:	Marvin Williams, New Buffalo, MI	Issue Date of Patent:	-
Title Of Invention:	Combined intercropping and mulching method		

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Publication Review

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06-28-2006	Date Forwarded to Examiner
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08-19-2005	Supplemental Response
07-26-2005	Date Forwarded to Examiner
07-18-2005	Informal or Non-Responsive Amendment after Examiner Action

RELATED APPEALS AND INTERFERENCES

There is a prior appeal from final rejection of all claims in Application No. 09/752, 956, now U.S. Pat. No. US 6,631,585 B1. There are no decisions of a court or the Board of Patent Appeals and Interferences.